

# *Philippine Mangrove Swamps*

*By William H. Brown, Ph. D.*

*Chief, Division of Investigation, Bureau of Forestry; Plant Physiologist, Bureau of  
Science; and Associate Professor of Botany, University of the Philippines,  
and*

*Arthur F. Fischer, C. E., M. F.*

*Director of Forestry; Dean and Professor of Forestry, School of Forestry,  
University of the Philippines*



*Department of Agriculture and Natural Resources  
Bureau of Forestry*

*Bulletin No. 17*

*Arthur F. Fischer, Director of Forestry*

MANILA  
BUREAU OF PRINTING  
1918

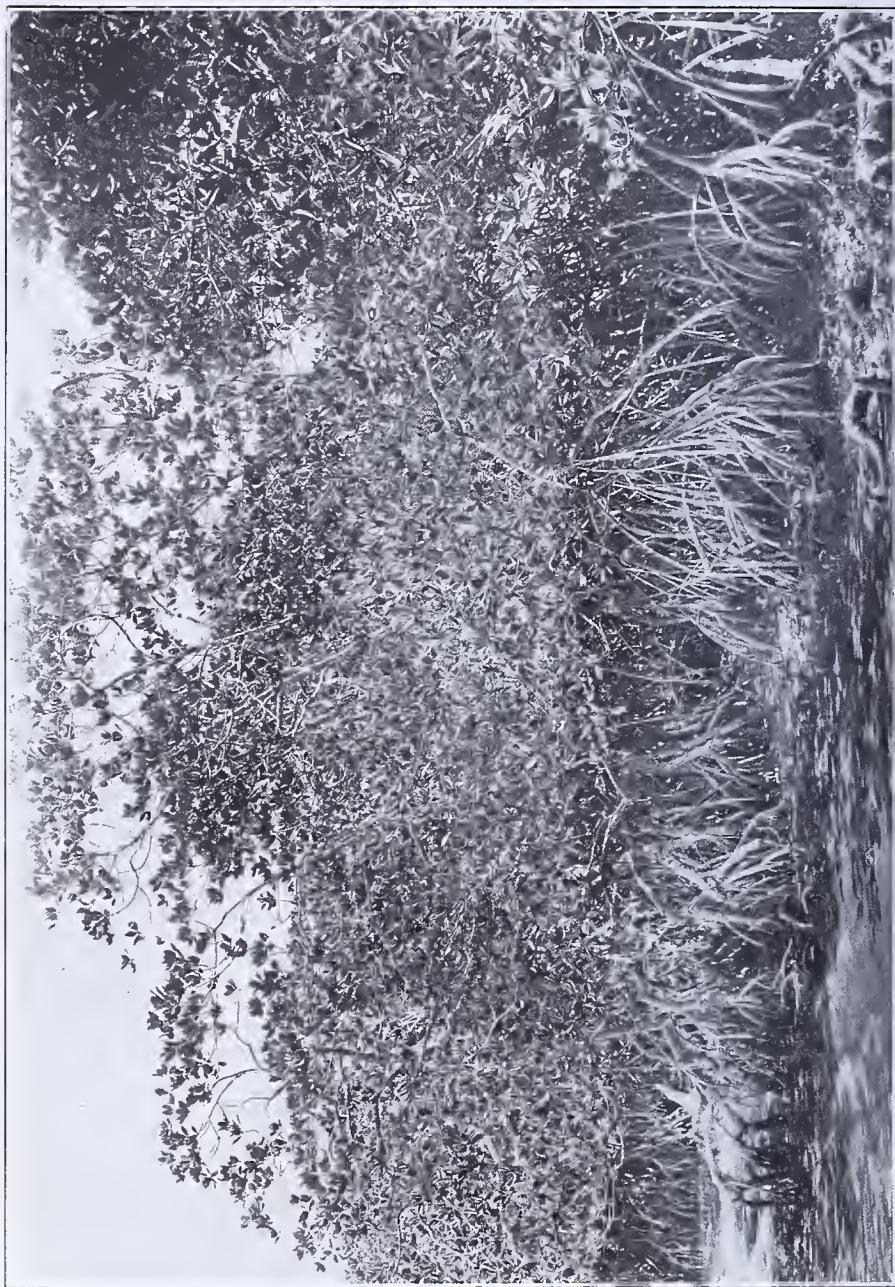


PLATE 1. RHIZOPHORA CANDELARIA INVADING A MUD FLAT.

# *Philippine Mangrove Swamps*

*By William H. Brown, Ph. D.*

*Chief, Division of Investigation, Bureau of Forestry; Plant Physiologist, Bureau of  
Science; and Associate Professor of Botany, University of the Philippines,  
and*

*Arthur F. Fischer, C. E., M. F.*

*Director of Forestry; Dean and Professor of Forestry, School of Forestry,  
University of the Philippines*



*Department of Agriculture and Natural Resources  
Bureau of Forestry*

*Bulletin No. 17*

*Arthur F. Fischer, Director of Forestry*

MANILA  
BUREAU OF PRINTING  
1918

Digitized by the Internet Archive  
in 2019 with funding from

This project is made possible by a grant from the Institute of Museum and Library Services as administered by the Pennsylvania Department of Education through the Office of Commonwealth Libraries

# CONTENTS

	Page.
ILLUSTRATIONS .....	5
PREFACE .....	9
INTRODUCTION .....	11
LIST OF SPECIES.....	22
LOCAL NAMES IN VARIOUS COUNTRIES.....	23
KEYS TO GENERA.....	24
DESCRIPTION OF SPECIES.....	26
Acrostichum .....	26
Nipa .....	26
Oncosperma .....	30
Xylocarpus .....	30
Excoecaria .....	34
Brownlowia .....	34
Campostemon .....	34
Heritiera .....	36
Sonneratia .....	38
Bruguiera .....	42
Ceriops .....	54
Rhizophora .....	56
Lumnitzera .....	62
Osbornia .....	66
Aegiceras .....	66
Cerbera .....	70
Avicennia .....	74
Acanthus .....	76
Scyphiphora .....	78
Pluchea .....	78
STANDS IN MANGROVE SWAMPS.....	80
CULTIVATION OF RHIZOPHORA (BAKAUAN).....	94
FIREWOODS .....	105
TANBARKS AND DYE BARKS.....	112
ECONOMIC USES OF THE NIPA PALM.....	119
FOREST CHARGES .....	126
INDEX .....	129



# ILLUSTRATIONS

## PLATE I

*Rhizophora candelaria* invading a mud flat..... Frontispiece.

## PLATE II

	Page.
FIG. 1. Looking across a mangrove swamp at head of Tubugan Bay, Port Banga, Zamboanga. Yacal forest on hills in background. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 1.....	12
2. Swamps along coast, under water at high tide. Guinayanagan, Tayabas. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 1.....	12

## PLATE III

Interior view of a mangrove swamp. The large tree is <i>Sonneratia caseolaris</i> (pagatpat), those trees with prop roots are <i>Rhizophora conjugata</i> (bakauan), and the smaller without prop roots are mainly <i>Bruguiera parviflora</i> . Bongabon, Mindoro .....	13
--	----

## PLATE IV

Interior view of a mangrove swamp. The large tree is <i>Sonneratia caseolaris</i> (pagatpat), otherwise the stand is almost purely <i>Bruguiera parviflora</i> . Bongabon, Mindoro....	15
--	----

## PLATE V

Roots of <i>Avicennia officinalis</i> exposed by wave action.....	17
---	----

## PLATE VI

FIG. 1. <i>Myrmecodia</i> , a plant inhabited by ants.....	19
2. A section through the base of a <i>Myrmecodia</i> .....	19

## PLATE VII

FIG. 1. <i>Hydnophytum</i> , a plant inhabited by ants. Diameter of base 40 centimeters .....	21
2. <i>Polypodium sinuatum</i> , a plant inhabited by ants.....	21

## PLATE VIII

<i>Acrostichum aureum</i> .....	27
---------------------------------	----

## PLATE IX

Nipa palm with flowers and fruit. From Philippine Agr. Rev., Vol. IX, No. 3 (1916).....	28
---	----

## PLATE X

FIG. 1. Fruit of nipa. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 2.....	29
2. Section of fruit of nipa. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 2.....	29

## PLATE XI

	Page.
FIG. 1. <i>Xylocarpus granatum</i> with immature fruit.....	31
2. A germinating seed of <i>Xylocarpus granatum</i> .....	31

## PLATE XII

<i>Xylocarpus moluccensis</i> .....	33
-------------------------------------	----

## PLATE XIII

FIG. 1. <i>Excoecaria agallocha</i> with fruits.....	35
2. <i>Camptostemon philippinense</i> with fruits.....	35

## PLATE XIV

<i>Heritiera littoralis</i> , fruits and flowers.....	37
---	----

## PLATE XV

<i>Sonneratia alba</i> , fruit and flower.....	39
--	----

## PLATE XVI

FIG. 1. <i>Sonneratia caseolaris</i> on an open coast. An old beach has been eroded, leaving a lagoon containing a mangrove swamp on the open coast. Bongabon, Mindoro. Reprint Philippine Journ. Sci., Sec. A, Vol. VI, No. 1.....	41
2. Air roots of <i>Sonneratia caseolaris</i> . Trees growing in salt water. From Philippine Journ. Sci., Sec. A, Vol. VI, No 1..	41

## PLATE XVII

<i>Sonneratia caseolaris</i> , flower and fruits.....	43
---	----

## PLATE XVIII

<i>Bruguiera conjugata</i> with flowers.....	45
--	----

## PLATE XIX

<i>Bruguiera sexangula</i> with flowers.....	47
--	----

## PLATE XX

<i>Bruguiera sexangula</i> with immature fruit.....	49
---	----

## PLATE XXI

<i>Bruguiera cylindrica</i> , fruits and flowers.....	50 <sup>b</sup>
---	-----------------

## PLATE XXII

<i>Bruguiera cylindrica</i> with flowers.....	51
---	----

## PLATE XXIII

<i>Bruguiera parviflora</i> with flowers.....	53
---	----

## PLATE XXIV

Fruit of <i>Bruguiera parviflora</i> .....	55
--	----

## PLATE XXV

<i>Ceriops roxburghiana</i> with flowers.....	57
---	----

## PLATE XXVI

<i>Ceriops roxburghiana</i> with fruits.....	58
--	----

## PLATE XXVII

	Page.
<i>Rhizophora candelaria</i> , fruit and old flowers from which petals have fallen.....	59

## PLATE XXVIII

<i>Rhizophora mucronata</i> , inflorescences and flower.....	61
--	----

## PLATE XXIX

<i>Rhizophora mucronata</i> with fruit.....	63
---	----

## PLATE XXX

<i>Lumnitzera littorea</i> , flowers and fruit.....	65
---	----

## PLATE XXXI

<i>Osbornia octodonta</i> with fruits.....	67
--	----

## PLATE XXXII

<i>Aegiceras corniculatum</i> with flowers.....	68
---	----

## PLATE XXXIII

Flowers of <i>Aegiceras corniculatum</i> .....	69
--	----

## PLATE XXXIV

<i>Aegiceras corniculatum</i> with fruits.....	71
--	----

## PLATE XXXV

<i>Aegiceras floridum</i> with immature fruits.....	72
---	----

## PLATE XXXVI

<i>Cerbera manghas</i> , flowers and fruit.....	73
---	----

## PLATE XXXVII

<i>Avicennia officinalis</i> with fruits and flowers.....	75
---	----

## PLATE XXXVIII

<i>Avicennia officinalis</i> with air roots.....	77
--	----

## PLATE XXXIX

<i>Acanthus ilicifolius</i> , flowers and fruit.....	79
--	----

## PLATE XL

<i>Scyphiphora hydrophyllacea</i> , fruits and flowers.....	81
---	----

## PLATE XLI

FIG. 1. Pototan tree, along seacoast at low tide. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 1.....	85
2. Pototan; lower trunk and roots. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 1.....	85

## PLATE XLII

- |  | Page. |
|--|-------|
| FIG. 1. Mangrove swamp at <i>sitio</i> Limbagujan. Stumps of tañgál ( <i>Ceriops</i> ) in foreground. Trees of <i>Rhizophora</i> (bakauan) and <i>Bruguiera</i> . From Philippine Journ. Sci., Sec. A, Vol. VI, No. 1..... | 89    |
| 2. Mangrove swamp. View of pieces of bakauan <i>rajas</i> (firewood). Masbate. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 1.....  | 89    |

## PLATE XLIII

- |  |     |
|--|-----|
| FIG. 1. Piled firewood cut mainly from sawed species of tañgál and bakauan. Southwest coast of Camarines. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 1..... | 107 |
| 2. Lorchia load of <i>rajas</i> (firewood), three hours consumed in loading, two for discharging. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 1.....         | 107 |

## PLATE XLIV

- |   |     |
|---|-----|
| FIG. 1. Marketing firewood in Manila. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 1.....            | 109 |
| 2. Firewood piled for sale in the Manila market. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 1..... | 109 |

## PLATE XLV

- |   |     |
|---|-----|
| FIG. 1. View from top of San Esteban distillery. Nipa swamps as far as the eye can reach. Nipa houses in the foreground. (Photograph by Martin.) From Philippine Journ. Sci., Sec. A, Vol. VI, No. 2..... | 121 |
| 2. Uncultivated nipa swamp. Legaspi, Albay Province. (Photograph by Martin.) From Philippine Journ. Sci., Sec. A, Vol. VI, No. 2.....   | 121 |

## PLATE XLVI

- |  |     |
|--|-----|
| Cultivated nipa swamp. Bulacan. (Photograph by Martin.) From Philippine Journ. Sci., Sec. A, Vol. VI, No. 2..... | 123 |
|--|-----|

## PLATE XLVII

- |  |     |
|--|-----|
| FIG. 1. Collecting the nipa sap. Showing a native collector and two bamboo joints (tuquils) in position to receive the sap. (Photograph by Martin.) From Philippine Journ. Sci., Sec. A, Vol. VI, No. 2..... | 125 |
| 2. Nipa palms in fruit. From Philippine Journ. Sci., Sec. A, Vol. VI, No. 2.....   | 125 |

## PREFACE

This bulletin is the third in a series dealing with minor forest products. Although the mangrove swamps produce valuable woods, they have been included in this series on account of the fact that they are utilized more for their minor forest products than for timber. The principal minor forest products derived from them are firewoods, tanbarks, dye barks, and the various products of the nipa palm, including thatching material and alcohol. The nipa palm is also a promising commercial source of sugar. Besides the products just mentioned, there are a number of other minor ones which will be discussed in the text.

The mangrove swamps constitute a very valuable asset to the Philippine Islands and, if properly managed, will prove to be a permanent source of considerable income both to the people and the Government. This bulletin is presented in the hope that it will aid in giving a better understanding of the swamps, their commercial possibilities, and the methods of their utilization.

In preparing this bulletin we have made use of records in the Bureau of Forestry, and have taken considerable information from a bulletin on Mangrove and Nipah Swamps of British North Borneo, by F. W. Foxworthy and D. M. Matthews. The descriptions of the various woods are taken from Bulletin 14, Commercial Woods of the Philippines, by E. E. Schneider. The writers are greatly indebted to Mr. E. D. Merrill, of the Bureau of Science, for very valuable help in preparing this bulletin and to Dr. F. W. Foxworthy for criticising the manuscript. The pictures of the flowering and fruiting specimens were taken for the writers through the courtesy of the Bureau of Science by the official government photographer, Mr. E. Cortes. The two drawings were made by Mr. J. K. Santos, assistant in botany, University of the Philippines. Mr. R. C. McGregor, special editor of the Philippine Journal of Science, has been of great assistance in helping in the preparation of this manuscript for the printer. For the above assistance we desire here to express our grateful appreciation.

WILLIAM H. BROWN.  
ARTHUR F. FISCHER.



# PHILIPPINE MANGROVE SWAMPS

By WILLIAM H. BROWN AND ARTHUR F. FISCHER

## INTRODUCTION

The mangrove swamps of the Philippine Islands apparently occupy between 400,000 and 500,000 hectares. No accurate survey of them has been made and the estimate of the area is based on reports from forest officers, Coast and Geodetic Survey maps, and forest maps. The area may exceed what is here given, but it is believed that it will not be less. The figure given includes also most of the areas of nipa swamps, as the classification has not, in most cases, been exact enough to show, in detail, how much of the swamp was in mangrove and how much in nipa.

The term mangrove swamp is applied to the type of forest occurring on tidal flats along sea coasts. They are found fringing the shores of the islands of the Philippine Archipelago and extending inland along the streams where the water is brackish (Plate II). The conditions most favorable for their development are found in quiet bays into which flow large rivers whose lower reaches have little fall.

The descending waters of the river are checked when they meet tidewater and deposit their sediment in the form of broad mud flats or deltas near the mouths of the rivers.

These flats are usually cut by a network of channels through which the advancing and receding waters of the sea move. At extreme low tide the flats are exposed and often even the larger channels are dry.

On these mud flats the trees and other plants which form the mangrove and nipa-swamp vegetation find conditions favorable to their development and, as the seeds of these species are distributed by water and can be transported for long distances without injury, the formation of flats and their seeding are practically simultaneous. The growth of all species is very rapid and the flats soon become dense forest, and remain so as long as the conditions which produced them are not disturbed (Plates III, IV). When the shore formation is favorable, new flats are formed beyond the old and the forest advances year



Fig. 1. Looking across a mangrove swamp at head of Tubugan Bay, Port Banga, Zamboanga.



Fig. 2. Swamps along coast, under water at high tide.



PLATE III. INTERIOR VIEW OF A MANGROVE SWAMP.

by year; its area diminishing or increasing as the lands drained or filled in by the action of the river are of greater or less extent than those newly formed. The draining and filling in of the lands on the upper limits of the swamp is very gradual, so that although the change from mangrove to dry forest is characteristic of these areas the process is extremely slow and less noticeable than the advance of the forest over newly formed flats on the sea edge of the swamp.

The mangrove forests may contain trees 1.35 meters in diameter; and when fully stocked, with mature timber, compare favorably with the commercial forests of the land. Areas with 650 cubic meters per hectare are found in the older swamps. These forests are not swamps and marshes, as we think of them in temperate regions, where trees grow in wet places that are periodically covered with standing water; but are literally forests of the sea with their roots in a stratum in which salt water is always present. For the greater part of the time the roots and even the lower part of the trunks of the trees are submerged in from 0.5 to 1 meter of salt water, while at high tide the lower limbs and foliage of the trees on the edges of the swamp are often submerged for a short time without injury (Plate II, fig. 1); conditions of life that would absolutely destroy ordinary forest trees.

Their character as forests of the sea is emphasized by the fact that when they form narrow strips, coral and sand beaches are often found back of the swamps on exposed coasts. The vegetation on these mud flats can be divided into two classes; mangrove swamps, in which large trees are present, and nipa swamps, which are characterized by a growth of the stemless palm, *Nipa fruticans*.

Mangrove-swamp forests, or "mangles," as they are called locally, are usually made up of thick stands of medium-sized and even-aged trees. Normally they are very free from undergrowth other than seedlings, and are characterized by the presence of roots showing on or above the surface of the ground (Plates I, III, IV, V, XVI, XXXVIII, and XLI). Depending upon the species in question, these may take the form of erect roots, knees, high prop roots, or mere swollen roots with side branches extending along the surface of the ground. The air roots have a spongy texture and absorb air which serves for the aëration of the root system. These peculiar roots are one of the most distinguishing characteristics of mangrove swamps. When the mud flats are not covered with water, the roots give a very peculiar appearance to the vegetation.



PLATE IV. INTERIOR VIEW OF A MANGROVE SWAMP.

The main tree species in a virgin swamp are few in number, and the principal ones are of the botanical family Rhizophoraceae. In this family there are found: *Rhizophora candelaria* and *R. mucronata*; *Ceriops tagal* and *C. roxburghiana*; and *Bruguiera conjugata*, *B. parviflora*, *B. cylindrica*, and *B. sexangula*. While these eight species are the ones most numerous in nearly all virgin swamps, scattered trees of pagatpat (*Sonneratia caseolaris*) often occur mixed with them or growing along exposed coral beaches. Api-api (*Avicennia* spp.) is sometimes found scattered in the more open places. Occasionally, this last-mentioned tree grows in pure stands along the inland edge of a mangrove swamp. Trees of the genus *Rhizophora* are frequently the first to seed upon and occupy the newly formed mud flats (Plate I). They are prop-rooted species, and normally grow on those portions of the swamp most deeply flooded by the tides. Such places are usually confined to the area along or close to water channels, although on low swamps *Rhizophora* forest extends farther inland. *Rhizophora mucronata* predominates in the fringe of trees bordering on waterways, while *Rhizophora candelaria* is by far commoner in the main forest within this outer fringe.

Trees of the genus *Bruguiera* occupy the portion of the swamp in which the ground is barely, if at all, flooded at high tide. Such places are usually toward the inland portions of the swamp and often, probably in the majority of cases, comprise a large percentage of its total area. As the ground level is raised by the natural filling in of the delta, it often happens that areas occupied by these *Bruguiera* forests become so high that they are seldom, if ever, flooded.

In open bays where the soil is mixed with considerable sand or coral limestone, there is a distinct frontal zone of *Sonneratia caseolaris* (Plate XVI), with some *Avicennia officinalis*. Wave-cut coral terraces often contain nearly pure stands of *Sonneratia caseolaris*.

Several other trees occur in these salt swamps, usually along their inner edges or in places where the stands are light. These include *Xylocarpus moluccensis*, *X. granatum*, *Lumnitzera littorea*, and *Aegiceras corniculatum*. *Heritiera littoralis* (dungonlate) is common on the higher ground which is still within the zone affected by salt water.

In swamp areas in which cutting has long been carried on the original and more valuable species are often largely replaced by *Avicennia* spp. (api-api). These species were considered to be of little value until the present fuel shortage.



PLATE V. ROOTS OF AVICENNIA OFFICINALIS EXPOSED BY WAVE ACTION.

Skirting the inland portions of the water channels, through which the tide ebbs and flows, is often found a strip of nipa palm (*Nipa fruticans*), usually narrow, although sometimes it occupies areas of considerable extent (Plates IX, XLV). In Pangil Bay, Mindanao, there is a single area of nipa covering 9,000 hectares. Nipa grows farther up the streams flowing through the mangrove forests than do the trees forming them, being found along streams where the effect of tide is barely noticeable. In some places the mangrove trees have been killed or cut out and nipa planted over wide areas of swamp. Such is the case north of Manila Bay, where much of the original tree growth has been entirely replaced by nipa.

Nipa has a large, branching, horizontal rhizome, or underground stem, which grows just below, or on the surface of, the soil and sends up short branches with a cluster of pinnate leaves, which rise 7 meters or more above the ground. Nipa frequently forms a dense mass of vegetation which is difficult to penetrate.

Undergrowth in a heavy virgin swamp is usually scanty, but in places where stands are light, in cut-over areas, and along the outer edges of the swamp, a fairly heavy undergrowth of vines, shrubs, ferns, and herbs is developed. Very noticeable in this are a swamp fern, *Acrostichum aureum*, and two spiny-leaved undershrubs, *Acanthus ilicifolius* and *A. ebracteatus*.

Among the commonest woody vines are *Derris trifoliata* Lour. (*D. uliginosa* Benth.), *Tristellateia australasiae* L. C. Rich., *Dalbergia candenatensis* Prain, *Caesalpinia nuga* Ait., *Caesalpinia crista* Linn., and *Finlaysonia obovata* Wall. Herbaceous vines are represented by the epiphytes *Hoya* and *Dischidia*.

Epiphytes are fairly numerous throughout the swamps. Perhaps the most conspicuous elements are the orchids, especially species of *Cymbidium* and *Dendrobium*. Epiphytic ferns are represented by *Drynaria quercifolia* J. Sm., *Polypodium sinuatum* Wall., and sometimes *Asplenium nidus* L. The most peculiar epiphytes are those containing cavities which are inhabited by ants. These are very abundant and are represented by *Myrmecodia*, *Hydnophytum*, and *Polypodium sinuatum* Wall. The bases of the stems of *Hydnophytum* and *Myrmecodia* are greatly enlarged and contain labyrinth cavities in which ants are found in large numbers (Plates VI, VII). The stems of *Polypodium sinuatum* are swollen and hollow, the cavities being inhabited by ants (Plate VII). *Dischidia saccata* Warb. is



Fig. 1. Myrmecodia, a plant inhabited by ants.



Fig. 2. A section through the base of a Myrmecodia.

found in some swamps. This plant has hollow leaves in which ants are found.

Reproduction is prolific in almost all places where seed trees are found, except along the higher inland portions of the swamp.

Back of the swamps are found numerous characteristic strand plants, and representatives of nearly all such plants in the region may be found in such situations. Among the common trees and shrubs back of the swamps are *Glochidion littorale* Blume, *Hibiscus tiliaceus* Linn., *Thespesia populnea* Corr., and *Barringtonia racemosa* Roxb. The sedge *Fimbristylis ferruginea* Vahl practically always occurs in such places, while along muddy banks *Cyperus malaccensis* Lam. is very common.

The chief commercial value of mangrove-swamp trees is for the production of firewood, charcoal, tannin, and dye barks. Some of the woods are also used for ship timbers, posts, ties, telegraph poles, piling, construction, finish, and furniture.

The nipa palm is very valuable as a source of thatching and alcohol and offers considerable possibilities for the production of sugar. For a discussion of the products of mangrove trees and the nipa palm, see the sections on these various subjects.

Mangrove trees serve a useful purpose in preserving water courses through the deltas at mouths of rivers. That they may be used to advantage to retain soil in engineering projects is shown by the following quotation:\*

The latest use of the mangrove in a practical way and one of which the writer has personal knowledge is the use of these trees as ballast retainers. This has been effectively demonstrated by the Florida East Coast Railway which has used the peculiar habit of the mangrove to advantage in their great feat of engineering, viz., the Oversea extension. At certain places these keys are connected by embankments supporting the road bed or where the bed is built high over a low flat key, the mangroves have been planted to prevent the erosive action of the sea on the ballast. This has been of greatest importance to the railroad and has protected the dykes just as the mangroves naturally sown have formed and protected young islands. Still more recently the writer has been of some small service to a large asphalt company concerning their engineering projects in Venezuela in which it is proposed to plant *Rhizophora mangle* along the dykes and jetties, etc., as a ballast retainer. This, it is hoped, will prove as efficient as the plantings of the Florida East Coast Railway have been in aiding the engineer in the tropics.

Mangrove swamps occur in similar situations in the tropics

---

\* Bowman, H. H. M., Ecology and Physiology of the Red Mangrove. Proceedings of the American Philosophical Society, Vol. LVI (1917) pp. 589-672.



Fig. 1. *Hydnophytum*, a plant inhabited by ants.

PLATE VII.

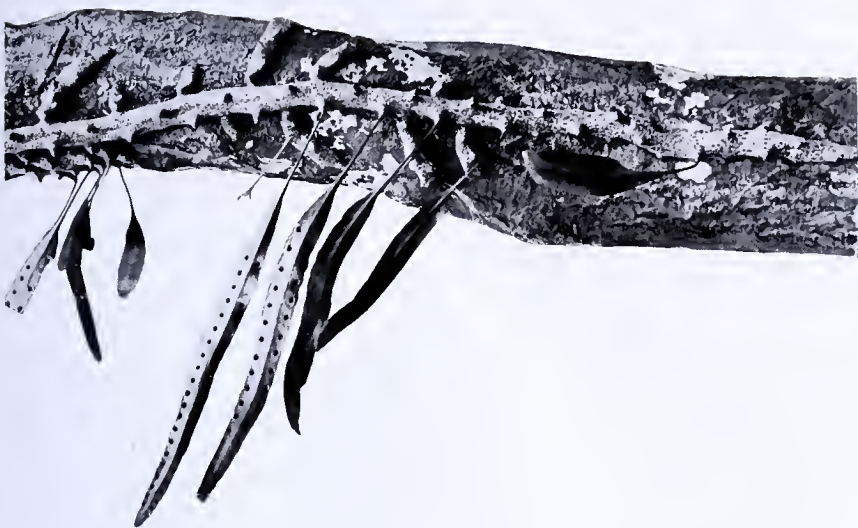


Fig. 2. *Polypodium sinuatum*, a plant inhabited by ants.

of both hemispheres. The Rhizophoraceae are the most prominent trees in all cases, but the species are different in America and in the Indo-Malayan regions. The composition is, however, very similar in East Africa and the Indo-Malayan regions. The tree species are few in number. In the Philippines twenty-five dicotyledonous trees have been reported from the mangrove swamps. The wide distribution of the species and the number of individuals of single species in the swamps make these forests unique among tropical forests.

LIST OF SPECIES IN PHILIPPINE MANGROVE SWAMPS WITH NATIVE  
AND FAMILY NAMES

- Acrostichum aureum* Linn. Lagolo. Polypodiaceae.  
*Nipa fruticans* Wurmb. Nipa. Palmae.  
*Oncosperma filamentosa* Blume. Anibong. Palmae.  
*Xylocarpus granatum* (obovatus) Koen. Tabígi. Meliaceae.  
*Xylocarpus moluccensis* (Lam.) M. Roem. Piagáu. Meliaceae.  
*Excoecaria agallocha* Linn. Buta-buta. Euphorbiaceae.  
*Brownlowia lanceolata* Benth. Maragomon. Tiliaceae.  
*Campostemon* (Cumíngia) *philippinense* (Vidal) Becc. Gapas-gápas.  
 Bombacaceae.  
*Heritiera littoralis* Dryand. Duñgon-láte. Sterculiaceae.  
*Sonneratia alba* (acida) Sm. Pedada. Sonneratiaceae.  
*Sonneratia caseolaris* (pagatpat) (Linn.) Engl. Pagatpát. Sonneratiaceae.  
*Bruguiera conjugata* (gymnorrhiza) (Linn.) Merr. Busáin. Rhizophoraceae.  
*Bruguiera cylindrica* (caryophylloides) (Linn.) Blume. Potótan-laláki.  
 Rhizophoraceae.  
*Bruguiera parviflora* W. & A. Lañgárai. Rhizophoraceae.  
*Bruguiera sexangula* (eripetala) (Lour.) Poir. Potótan. Rhizophoraceae.  
*Ceriops roxburghiana* Arn. Tañgál. Rhizophoraceae.  
*Ceriops tagal* (Perr.) C. B. Rob. Tañgál. Rhizophoraceae.  
*Rhizophora candelaria* (conjugata) DC. Bakáuan-laláki. Rhizophoraceae.  
*Rhizophora mucronata* Lam. Bakáuan-babae. Rhizophoraceae.  
*Lumnitzera littorea* Voigt. Tabáu. Combretaceae.  
*Lumnitzera racemosa* Willd. Kulási. Combretaceae.  
*Osbornia octodonta* F. Muell. Tawalis. Myrtaceae.  
*Aegiceras corniculatum* (Linn.) Blanco. Saging-saging. Myrsinaceae.  
*Aegiceras floridum* R. and S. Tinduktindukan. Myrsinaceae.  
*Cerbera manghas* (odollam) Linn. Baraybáy. Apocynaceae.  
*Avicennia alba* Blume. Api-api. Verbenaceae.  
*Avicennia officinalis* Linn. Api-api. Verbenaceae.  
*Acanthus ebracteatus* Vahl. Tigbao. Acanthaceae.  
*Acanthus ilicifolius* Linn. Diliuariu. Acanthaceae.  
*Scyphiphora hydrophyllacea* Gaertn. Nilad. Rubiaceae.  
*Pluchea indica* Linn. Kalapini. Compositae.

*Scientific and local names of various mangrove species.\**

Scientific names.	Local names.				
	Philippine Islands.	British North Borneo.	Sarawak.	Dutch Borneo.	Malay Peninsula and Singapore.
<i>Rhizophora</i> spp. ....	Bakauan { Bakauan lalaki } Bakauan { Bakauan babae }	Bakau { Bankita } Taggai }	Bako .....	Bako .....	Baku.
<i>Ceriops</i> spp. ....	Tangal .....	Tengah .....	Tengah .....	Hulit-tengah .....	Tengar.
<i>Bruguiera conjugata</i> {	Pototan or Busain .....	Lenggadi or Pututan .....	Putut .....	Akat .....	Tumu.
<i>Bruguiera parviflora</i> .....	Langarai .....	B'eus .....	B'rus .....	B'eus .....	Lenggadai.
<i>Avicennia</i> spp. ....	Api-api .....	Api-api .....	Api-api .....	Api-api .....	Api-api.
<i>Lumnitzera littorea</i> .....	Tabau .....	Griting .....	Taruntum .....	Griting .....	Terentum.
<i>Sonneratia caseolaris</i> .....	Pagatpat .....	Perapat .....	Perapat .....	Perapat .....	Perepat.
<i>Sonneratia alba</i> .....	Pedada .....	Pedada .....	Pedada .....	Pedada .....	Pedada.
<i>Heritiera littoralis</i> .....	Dungon-late .....	Dungun .....	Dungun .....	Dungun .....	Dungun.
<i>Xylocarpus granatum</i> .....	Tabigi .....	Nirih .....	Nirih .....	Nirih .....	Nyireh.
<i>Xylocarpus moluccensis</i> .....	Piagao .....	Nirih .....	Niri .....	Niri .....	Nyireh batu.
<i>Campostemon philippinense</i> .....	Gapas-gapas .....	Manggating .....	Manggating .....	Manggating .....	
<i>Nipa fruticans</i> .....	Nipa .....	Nipah .....	Nipah .....	Nipa or Hapong .....	Nipah.
<i>Oncosperma filamentosum</i> .....	Anibong .....	Nibong .....	Nibong .....	Nijboeng .....	Nibong.
<i>Acanthus ilicifolius</i> .....	Diliuariu .....	Nibong .....		Djoeroedjoe .....	Jeruju.
<i>Scyphiphora hydrophyllacea</i> .....	Sagasa .....				Chengam.
<i>Aegiceras corniculatum</i> .....	Saging-saging .....			Troentoem .....	Kachang-kachang.
<i>Excoecaria agallocha</i> .....	Buta-buta .....	Buta-buta .....	Buta-buta .....	Taboeta .....	Buta-buta.
<i>Acrostichum aureum</i> .....	Lagolo .....	Piay .....		Pakos larat .....	Paku laut, Piai.

\* From Foxworthy, F. W., and Matthews, D. M., Mangrove and nipah swamps of British North Borneo, Bulletin 3 (1917) Department of Forestry British North Borneo. Revised by Dr. F. W. Foxworthy.

*Key to the genera of mangrove-swamp plants.*

[Based on superficial characters.]

## 1. Palms.

2. Stemless, with underground rhizomes; without spines.. *Nipa*, page 262. Trunks erect with numerous, long, slender spines.. *Oncosperma*, page 301. A large coarse fern with pinnate leaves rising in a cluster from the base ..... *Acrostichum*, page 26

## 1. Not palms or ferns.

2. Leaves pinnate with one to three pairs of leaflets. Large trees with round fruit 8 to 25 centimeters in diameter and containing a few, very large, angular seeds..... *Xylocarpus*, page 30

2. Leaves not pinnate; fruits not as above.

## 3. Leaves opposite.

4. Herbs or shrubs with spiny-margined leaves.... *Acanthus*, page 76

4. Leaves not spiny.

5. Leaves usually pointed at the tip.

6. Tip of leaf with prominent projection of the midrib.

*Rhizophora*, page 56

6. Tip of leaf without projection of the midrib.

7. Petioles usually not over 2 or 3 millimeters in length.

*Sonneratia*, page 38

7. Petioles usually more than 6 millimeters in length.

8. Lower surface of leaves green; with long, slender seedling projecting from the fruit..... *Bruguiera*, page 428. Lower surface of leaves gray or white; fruit a capsule up to 2.5 centimeters in length and containing a single seed ..... *Avicennia*, page 74

5. Leaves rounded at apex and not notched; mature leaves usually more than 3 centimeters in breadth.

6. Petioles usually more than 1.5 centimeters long; flowers about 1 centimeter in length..... *Scyphiphora*, page 786. Petioles usually much less than 1.5 centimeters in length; flowers about 5 centimeters long..... *Sonneratia*, page 38

5. Some or all of the leaves slightly or conspicuously notched at apex.

6. Petioles very short, much less than 5 millimeters in length.

*Osbornia*, page 666. Petioles more than 1 centimeter in length.... *Ceriops*, page 54

## 3. Leaves alternate.

4. Small shrubs; leaves with toothed margin..... *Pluchea*, page 78

4. Margin of leaves smooth or nearly so.

5. Tips of leaves usually pointed, or lower surfaces of leaves with a silvery appearance.

6. Petioles more than 2 centimeters in length; plants with abundant milky juice.

7. Leaves more than 15 centimeters long; flowers large, white, terminal ..... *Cerbera*, page 707. Leaves less than 12 centimeters and usually less than 10 centimeters long; flowers very small, from branches below the leaves ..... *Excoecaria*, page 34

6. Petioles less than 2 centimeters in length; plants without milky juice.

7. Leaves rounded at the base..... *Heritiera*, page 367. Leaves pointed at the base..... *Brownlowia*, page 34

5. Apex of leaves rounded and usually notched.

6. Petioles usually about 2 or more centimeters in length; leaves, stems, and fruits densely covered with small round scales.

*Camptostemon*, page 34

6. Petioles 1 centimeter or less in length.

7. Fruits shaped like a banana except that the tips are sharply pointed ..... *Aegiceras*, page 66

7. Fruits not shaped like a banana..... *Lumnitzera*, page 62

*Key to the genera of mangrove-swamp plants.*

[Based on floral characters.]

1. Plant without flowers or seeds, reproduced by means of spores.

Family 1, Polypodiaceae; *Acrostichum*.

1. Plants with flowers that produce seeds.

2. Cotyledon one; leaves parallel-veined..... Family 2, Palmae.

3. With erect spiny trunk..... *Oncosperma*.

3. Without trunk and without spines..... *Nipa*.

2. Cotyledons two; leaves netted-veined.

3. Corolla none.

4. Ovary inferior..... Family 10, Combretaceae; *Lumnitzera*.

4. Ovary superior.

5. Flowers dioecious; plants with milky juice.

Family 4, Euphorbiaceae; *Excoecaria*.

5. Flowers monoecious; plants without milky juice.

Family 7, Sterculiaceae; *Heritiera*.

3. Calyx and corolla both present; the corolla of distinct and separate petals.

4. Ovary superior.

5. Stamens numerous, more than twice as many as the petals.

6. Filaments united, stamens on the outside of a column.

Family 6, Bombacaceae; *Camptostemon*.

6. Filaments free..... Family 5, Tiliaceae; *Brownlowia*.

5. Stamens few, never more than twice as many as the petals; inside of small cup-shaped tube.

Family 3, Meliaceae; *Xylocarpus*.

4. Ovary inferior.

5. Stamens numerous, many times as many as the petals.

6. Flowers small; calyx lobes imbricate in bud; leaves usually with glandular dots..... Family 11, Myrtaceae; *Osbornia*.

6. Flowers large; calyx lobes valvate in bud; leaves not glandular dotted..... Family 8, Sonneratiaceae; *Sonneratia*.

5. Stamens usually twice as many as the petals.

Family 9, Rhizophoraceae.

6. Petals four..... *Rhizophora*.

6. Petals five or six..... *Ceriops*.

6. Petals eight to fourteen..... *Bruguiera*.

3. Calyx and corolla both present; the petals more or less united.

4. Ovary superior.

5. Stamens opposite the lobes of the corolla, as many as the lobes.

Family 12, Myrsinaceae; *Aegiceras*.

5. Stamens as many as the lobes of the corolla in regular flowers and alternate with the lobes, or sometimes fewer in irregular flowers.

6. Carpels distinct, at least below, sometimes united at apex by the styles; plants with milky juice.

Family 13, Apocynaceae; *Cerbera*.

6. Carpels entirely united; plants with watery juice.

7. Fruits drupaceous; flowers small.

Family 14, Verbenaceae; *Avicennia*.

7. Fruits capsular, dehiscent; flowers large.

Family 15, Acanthaceae; *Acanthus*.

4. Ovary inferior.

5. Flowers not in dense heads; leaves opposite.

Family 16, Rubiaceae; *Scyphiphora*.

5. Flowers in dense heads; leaves alternate.

Family 17, Compositae; *Pluchea*.

## DESCRIPTION OF SPECIES

### Family 1, POLYPODIACEAE

#### Genus ACROSTICHUM

**ACROSTICHUM AUREUM** Linn. (Plate VIII).

LAGOLO.

Local names: *Piai* (Agusan); *pakupakuan* (Manila); *lapole* (Tayabas).

*Acrostichum aureum* occurs in great abundance on open mud flats in the swamp and along tidal streams. The leaves are pinnate, leathery, and from 50 to 200 centimeters in length. The leaflets are from 20 to 50 centimeters long and from 4 to 6 centimeters wide. *Acrostichum aureum* is distributed in the tropics of both hemispheres.

### Family 2, PALMAE

#### Key to the genera.

Stemless, with underground rhizomes; without spines..... *Nipa*.

Trunks erect with numerous, long, slender spines..... *Oncosperma*.

#### Genus NIPA

**NIPA FRUTICANS** Wurm. (Plates IX, X).

NIPA.

Local names: *Sasá*, *lása*, *páuid* (Tagalog); *sága* (Sambali), *táta*, *anípa* (Cagayan); *nípa* (Bikol).

This palm is at once distinguished from all others in the Philippines by its habit and habitat. It occurs along tidal streams throughout the Philippines and, from an economic standpoint, is one of the most important palms in the Archipelago. It is of special interest from the fact that it thrives only in brackish swamps. *Nipa* has a stout, creeping, subterranean stem or rhizome. The leaves are pinnate, 7 meters or more in length, and occur in erect clusters. *Nipa* frequently forms a dense mass of vegetation which is very difficult to penetrate. The



PLATE VIII. ACROSTICHUM AUREUM.



PLATE IX. NIPA FRUTICANS WITH FLOWERS AND FRUIT.



Fig. 1. Fruit of nipa.



Fig. 2. Section of fruit of nipa.

PLATE X.

fruits are flat and about 12 centimeters long by 10 centimeters broad. The inflorescence is very characteristic, notably the large, globose, fruiting head, which is up to 30 centimeters in diameter and borne on a special erect stalk. This plant apparently has no very definite blooming season, but as a general rule, at least in Bulacan and Pampanga Provinces, flowers during the months of February and March. It takes about four months for the fruit to ripen.

The methods of cultivation of nipa and its economic value as a source of thatching material, alcohol, and sugar will be discussed later.

#### Genus **ONCOSPERMA**

**ONCOSPERMA FILAMENTOSA** Blume.

ANIBONG.

Local name: *Anibong* (Tagalog and Bisaya).

Anibong can be at once recognized by the numerous, long, slender, horizontally spreading, stiff, sharp spines borne on the trunk throughout its length.

Like the other species of the genus, this is a rather tall, slender palm. It often grows subgregariously in favorable habitats, in ravines, or in lowlands back of the mangrove and often within the influence of brackish or salt water. The outer part of the trunk is very hard and durable; and split into narrow pieces is extensively used by the Filipinos, in the regions where it grows, for house floors. It is also used for spear shafts. The bud is edible, either raw or cooked; while in the Malay Archipelago, perhaps also in the Philippines, the fruits are sometimes used as a substitute for areca fruits in preparing buyo for chewing.

### Family 3, MELIACEAE

#### Genus **XYLOCARPUS**

##### *Key to the species.*

Bark light colored, smooth; fruit 17 to 25 centimeters in diameter.

*Xylocarpus granatum.*

Bark dark brown, very rough; fruit about the size of a small orange.

*Xylocarpus moluccensis.*

**XYLOCARPUS GRANATUM** Koen. (Plate XI).

TABÍGI.

Local names: *Tabigi* (Lanao, Cebu, Tayabas, Guimaras Island, Zamboanga, Negros, Dinagat Island, Camarines, Masbate, Agusan, Sorsogon, Leyte, Marinduque, Panay, Basilan, Palawan, Samar, Cotabato, Culion); *pulit* (Basilan Island); *kulimbánig* (Culion Island); *tambo-tambo* (Zamboanga); *lubanáyong* (Cagayan); *nigi* (Mindoro, Camarines, Palawan, Zambales, Tayabas); *piagáu* (Masbate, Zamboanga).



Fig. 2. A germinating seed of *Xylocarpus granatum*.



Fig. 1. *Xylocarpus granatum* with immature fruit.

PLATE XI.

This is a medium-sized to large tree, reaching a diameter of 100 centimeters, with thin, smooth, and light-colored bark. The bark contains a large amount of tannin. The inner bark is dark red and furnishes a dark red dye. The trunk is usually crooked and very often rotten. The roots frequently extend for a considerable distance through the mud. They are crooked, and the projecting parts are very narrow on top.

The wood is moderately hard and moderately heavy. The sapwood is small in amount, whitish; the heartwood red. The grain is straight or slightly crossed; the texture fine and glossy. The wood seasons very well, shrinking little and checking or warping hardly at all; works easily. It is rarely, if ever, attacked by beetles. It is used for poles; ties; posts; beams, joists, rafters; doors; flooring; all interior finish; high-grade furniture and cabinetwork; among the best and most beautiful cabinet woods in the Islands.

The leaves are alternate and compound with one to three pairs of leaflets. The flowering branches are usually from 3.5 to 7 centimeters in length. The flowers are about 6 millimeters long. The stalks are from 7 to 13 millimeters in length. The calyx has four rounded lobes. The four petals are much longer than the calyx, rounded, the edges overlapping. The fruit is from 17 to 25 centimeters in diameter and round, with a thick, corky, leathery covering, which usually splits into four pieces as the fruit dries. The fruit contains a number of corky, more or less pyramidal seeds, which float, with the small end up, until after germination.

**XYLOCARPUS MOLUCCENSIS** (Lam.) M. Roem. (Plate XII). PIAGÁU.

Local names: *Piagáu* (Mindoro, Zamboanga, Negros, Cotabato, Palawan, Guimaras Island); *lagut-út* (Guimaras Island); *tabigi* or *tibigi* (Mindoro and Cotabato); *puyugau* (Ticao Island); *sangkuyong* (Moro and Jolo); *piadak* (Palawan).

This species differs from the last in being straighter and taller; with dark, flaky bark; smaller fruits, about the size of an orange; and erect air roots. The wood is generally a little harder and darker in color than that of *Xylocarpus granatum*. The heartwood at the base of the trunk is often rotten. This tree reaches a diameter of 65 centimeters. The wood has the same uses as that of *Xylocarpus granatum*.

The leaves are compound, with two or three pairs of leaflets. The flowering branches are slender and from 7 to 25 centimeters in length. The flowers are similar to those of *Xylocarpus granatum*, but have rather broader petals and a shorter style. The fruit is rounded and about the size of a small orange.



PLATE XII. XYLOCARPUS MOLUCCENSIS.

## Family 4, EUPHORBIACEAE

## Genus EXCOECARIA

EXCOECARIA AGALLOCHA Linn. (Plate XIII).

BUTA-BUTA.

Local names: *Batano* (Pangasinan and Cagayan); *buta* (Basilan, Bataan, Mindoro, and Palawan); *buta-buta* (Bataan and Palawan); *lipata* (Palawan, Agusan, and Camarines); *lipatang-buhay* (Palawan); *alipata* (Negros); *kulasi* (Tayabas and Lanao).

*Excoecaria agallocha* is a small tree, usually not more than 8 meters in height, growing on firm mud or sand at the edge of the swamp or on relatively firm spots in swamps. The bark is light gray and broadly checked with darker streaks. It contains copious milky sap which is very poisonous, being said even to cause blindness when it touches the eyes.

The leaves are alternate, shiny, pointed at the tip and somewhat rounded at the base, and about 6 to 12 centimeters long. The flowers are very small and are densely crowded on slender flowering branches. The male flowers are found on spikes which grow singly in the axils of the leaves and are from 5 to 10 centimeters long. The female flowers occur on branches which are 2 to 3 centimeters long. There are three sepals, no petals, and three stamens. The fruits are composed of three sections, are somewhat rounded, smooth, and about 5 millimeters in diameter. The wood is pale brownish white, soft, and probably not used for any purpose but fuel.

## Family 5, TILIACEAE

## Genus BROWNLOWIA

BROWNLOWIA LANCEOLATA Benth.

MARAGOMON.

Local name: *Maragomon* (Bisaya).

This species is a shrub or a small tree. The leaves are pointed at both ends; 9 to 15 centimeters long, 3 to 4.5 centimeters wide; the upper surface when mature is smooth and shiny, the lower covered by a dense layer of minute, whitish yellow scales. The inflorescences have few flowers. The flowers are about 6 millimeters long; the stalks about the same length. The calyx is 5 millimeters long, bell-shaped, and divided into three to five lobes. There are five petals, which are longer than the calyx.

## Family 6, BOMBACACEAE

## Genus CAMPTOSTEMON

CAMPTOSTEMON PHILIPPINENSE (Vidal) Becc. (Plate XIII).

GAPAS-GÁPAS.

Local names: *Bunǵálon* (Tayabas); *gapas-gápas* (Negros, Capiz, Zamboanga); *dandúlit* (Zamboanga); *balúno* (Zamboanga); *libáto-putí*, *nígi-putí* (Tayabas).



Fig. 2. *Camptostemon philippinensis* with fruits.

PLATE XIII.



Fig. 1. *Excoecaria agallocha* with fruits.

A small tree, 6 to 10 meters high, the vegetative parts, buds, and fruits, covered with numerous small round scales. Leaves alternate, rather thick, crowded at the ends of the branches, margin smooth, apex rounded, base narrowed, 5 to 10 centimeters long, 3 to 6 centimeters wide, petioles 2 to 5 centimeters long. Flowers small, crowded at the tips of short axillary stalks, nearly white, and with five petals. The anthers are few in number and crowded at the apex of a short tube. The fruit is a small, pear-shaped capsule, about 1.5 centimeters long, and contains a few small seeds densely covered with a cottonlike substance.

The wood is moderately hard; of smooth, fine texture; pure creamy-white, but bluing easily in seasoning. It is a pretty wood, but little known and rarely cut except with mixed firewood.

### Family 7, STERCULIACEAE

#### Genus *HERITIERA*

*HERITIERA LITTORALIS* Dryand. (Plate XIV).

DUNĠON-LÁTE.

Local names: *Dunġon-láte* and *dunġon* (Tayabas, Baler, Negros, Butuan, Camarines, Masbate, Lanao, Palawan, Zamboanga, Mindoro, Bataan, Catabato, Zambales, Manila, Misamis, Leyte, Basilan, Surigao, Palaui Island, Sorsogon, Ticao, Guimaras, Agusan); *paunapin* (Cagayan); *magáyao* (Cagayan); *palugápig*, *palonġápoi*, *paronapin*, *paronápoi* (Cagayan, Pangasinan, Zambales); *baut* (Moro); *malarunġon* (Tayabas); *palonġapuy* (Iloko); *dunġon-lalao* (Tayabas); *bárit* (Zamboanga); *dumón* (Cagayan); *bayag-kabayo* (Manila).

This is a tree which grows on the inner part of the swamp and sometimes on dry land just back of the swamp. The bark is light-colored and coarsely furrowed. There is a thin outer layer which peels off readily and leaves a dark brown color. Most of the trees are small and useless, though occasionally large-sized trees are found. It may reach a diameter of about 90 centimeters and have a clear length of 13 meters.

The wood is very hard, heavy, very tough and flexible, but not resilient. The sapwood is up to 6 or 8 centimeters in thickness; in mature trees sharply marked off from heartwood. The heartwood is reddish brown to dark chocolate, often containing masses of stony deposits in old knots and heart cracks. The grain is crossed and sometimes curly; texture fine, dense, smooth, but not glossy. Logs and large timbers are liable to split deeply in seasoning; boards less liable to split, but must be piled carefully and heavily loaded to prevent warping. It is very difficult to work, both on account of its hardness and toughness, and because it dulls tools badly, even when no stony deposits are met. The heartwood is rarely attacked even by termites and only eaten slowly by teredos. The sapwood is rapidly



PLATE XIV. *HERITIERA LITTORALIS*, FRUITS AND FLOWERS.

attacked by both insects and fungi. The wood is used for piling; posts; foundation sills; ties, paving blocks, bridges, wharfs, and ship buildings; beams, joists, rafters; hubs, spokes, felloes, and axles; capstan bars and other levers; ax, pick, and other tool handles; mallets and other wooden tools; recommended for steamed bent work where great strength and durability are required.

The leaves are 10 to 20 centimeters long, alternate, simple, dark shiny green on the upper surface and silvery below. The flowering branches are borne in the axils of the leaves and are hairy and from 7 to 15 centimeters long with numerous flowers. The flowers are 5 millimeters long, unisexual, yellowish green, and bell-shaped. The flower has no petals. The calyx is usually 5-toothed. The anthers are borne in a ring. The fruit is hard, woody, smooth, shiny, 4 to 8 centimeters long, and boat-shaped.

### Family 8, SONNERATIACEAE

#### Genus SONNERATIA

There are two species of *Sonneratia* in the Philippine mangrove swamps, *Sonneratia alba* and *Sonneratia caseolaris*. These two species can be readily distinguished by the shapes of the leaves. The leaves of *Sonneratia alba* are narrow and pointed at the apex, while those of *Sonneratia caseolaris* are about as broad as long and rounded at the apex.

#### *Key to the species.*

Leaves pointed at apex..... *Sonneratia alba*.  
Leaves rounded at apex..... *Sonneratia caseolaris*.

**SONNERATIA ALBA** Sm. (Plate XV).

**PEDADA.**

Local names: *Payar* (Pangasinan); *palapát*, *palata*, *pagatpát*, and *hikau-hikauan* (Bataan); *pagatpát* (Manila, Bataan), *lukabban*, *ilukabban* (Cagayan).

This species is a small tree occurring along the upper stretches of tidal streams. The fruit is slightly acid and is used as an article of food and also for making vinegar. This tree rarely reaches a height of more than 9 meters. One individual with a diameter of 80 centimeters has been reported. The air roots and leaves are distinctly smaller than those of *Sonneratia caseolaris*. The air roots are sometimes used for the manufacture of wooden soles of shoes. The bark contains a moderate proportion of tannin, but is not often used as other species richer in tannin are more readily available.

The wood is whitish and moderately hard. It rarely, if ever, forms heartwood and is cut only with mixed inferior firewoods.

The smallest branches are jointed and four-angled. The leaves



PLATE XV. SONNERATIA ALBA, FRUIT AND FLOWER.

are thick and leathery, narrow, and taper to a broad, short petiole. They are from 4 to 10 centimeters long and from 2 to 4 centimeters wide. The flowers occur singly; the calyx is green, 2.5 to 3 centimeters long, and divided into six to eight angular lobes which are longer than the calyx tube. The petals are six in number, narrow, pink or white, and about as long as the calyx segments. The stamens are very numerous and the style long. The fruit is hard, 3 to 4 centimeters in diameter, rounded but depressed at the apex; the base is surrounded by the calyx tube, the lobes of which still persist when the fruit is mature. The fruit contains many seeds.

**SONNERATIA CASEOLARIS** (Linn.) Engl. (Plates XVI, XVIII). PAGATPÁT.

Local names: *Pagatpát* (Cebu, Camarines, Tayabas, Cagayan, Samar, Agusan, Basilan, Zambales, Cotabato, Palawan, Mindoro, Zamboanga, Panay, Guimaras Island, Negros, Leyte, Bataan, Lanao); *bunayon* (Dinagat Island); *patpát* (Butuan); *lukabban*, *ilukabbán*, *lukabbaán* (Cagayan); *pirara* and *palalan* (Cotabato); *bunḡálon* (Masbate).

This is a tree of the outer part of the swamp, and often occurs even on exposed reefs. The trunk is swollen at the base, at least when young. The air roots are usually from a few centimeters to 60 centimeters in length. In some places along river banks, where the tree is growing in soft mud, they are much longer, and have been known to reach a length of more than 2 meters. The bark is very dark gray. *Sonneratia caseolaris* may reach a diameter of 175 centimeters and a clear length of 26 meters.

The wood is moderately hard and moderately heavy to heavy. The sapwood is 3 to 8 centimeters thick, light grayish brown; the heartwood light brown to dark chocolate. When wet or under varnish, the heartwood of old mature trees looks almost black. The grain is straight or very slightly crossed; the texture fine, very homogeneous, smooth, but not glossy; it has a distinct salty taste and a fishy or swampy odor, especially when fresh. Boards season fairly well, but logs and heavy planks are liable to check internally. It is easy to work. It lasts well in the ground and even the sapwood is rarely attacked by insects; the heartwood is said to resist teredos very well. It is used for piles; posts, poles; ties; paving blocks; ship, bridge, and wharf building; general strong construction; doors; siding, sheathing, ceiling, flooring, and all kinds of interior finish; ship planking and decking; furniture and cabinetwork; and musical instruments. The wood contains a small amount of salt, making the use of copper nails and screws necessary. The air roots are used as floats for fish nets and, being corky in texture, are



Fig. 1. *Sonneratia caseolaris* on an open coast.



Fig. 2. Air roots of *Sonneratia caseolaris*.

employed in the manufacture of inner soles for shoes and can be used as a substitute for cork or pith.

The small branches are more rounded than in *Sonneratia alba*. The leaves are thick and leathery, rounded at the apex, 6 to 10 centimeters long, and nearly as wide as long. Two or three flower buds are usually found together. The calyx is green, leathery, 3 to 4 centimeters long, and divided into six to nine narrow segments, which are equal in length to the calyx tube or longer. The petals are white, narrow, and fall off very early; they are nearly as long as the calyx segments. Sometimes there are no petals. The stamens are very numerous and the style long. The fruit is hard, rounded, depressed at the apex, 3 to 4 centimeters in diameter, and surrounded nearly to the middle by the calyx tube, the lobes of which are still present when the fruit is mature. The fruit contains many seeds.

#### Family 9, RHIZOPHORACEAE

The family Rhizophoraceae is the most important one in the mangrove swamps and contains by far the largest number of species. The members of this family in the swamps are distinguished at once from all other species by the fact that the seed germinates and produces an elongated seedling before the fruit drops from the tree. This character is shown clearly in the illustrations of the members of this family. The conspicuous part of the seedling that projects from the fruit is the radicle or young root, which is very much longer than the plumule or young shoot. The family Rhizophoraceae is represented in the swamps by three genera; *Rhizophora*, *Bruguiera*, and *Ceriops*.

Trees of the genus *Rhizophora* are easily distinguished from all other trees in the swamps by the very numerous prop roots which grow out from the trunk and branches. These are shown very clearly on Plate I. The genera *Bruguiera* and *Ceriops* can be separated by the shapes of the leaves, which in *Bruguiera* are pointed at the apex and in *Ceriops* are rounded and notched at the apex.

#### Key to the genera.

1. Leaves pointed at apex.
  2. Tip of leaves with prominent projection of midrib..... *Rhizophora*.
  2. Tip of leaves without projection of midrib..... *Bruguiera*.
1. Leaves rounded and notched at apex..... *Ceriops*.

#### Genus BRUGUIERA

The genus *Bruguiera* is represented in the Philippines by four species: *Bruguiera conjugata* (busain), *B. cylindrica* (potótan-lalaki), *B. sexangula* (potótan), and *B. parviflora* (lan-



PLATE XVII. SONNERATIA CASEOLARIS, FLOWER AND FRUITS.

garai). The wood is hard and heavy to very heavy; the sapwood 2 to 4 centimeters thick, sometimes merging gradually into the darker heartwood, but often almost indistinguishable from it; the heartwood is pale dull red or reddish brown, sometimes with very irregular, narrow but ill-defined, dark streaks. The grain is straight and the texture fine. Beautiful conspicuous silver grain occurs on radial sections. Logs check badly in seasoning, but sawn lumber seasons without much checking and warping if properly stacked under a roof. The wood is hard to saw, but otherwise easy to work. It is said to last well in wet situations, is rarely attacked by insects, and is said to resist teredos for as much as seven or eight years. It has much the same uses as that of the genus *Rhizophora*.

The leaves of *Bruguiera* are usually leathery in texture, oblong, and entire. The flowers are rather large and are found in the axils of the leaves. The calyx is split into eight to fourteen lobes. The petals are oblong, and equal in number to the calyx-lobes, two-lobed or notched at the apex, embracing the stamens by pairs. There are sixteen to twenty-eight stamens. The ovary is two- to four-celled. The fruit is included in or joined to the calyx tube, is one-celled, one-seeded. The seed germinates on the tree.

The different species of *Bruguiera* are readily distinguished either in flower or fruit except in the case of *Bruguiera conjugata* and *Bruguiera sexangula*, which have forms intermediate in character between typical specimens of the two species. The flowers of *Bruguiera conjugata* and *Bruguiera sexangula* are large, 2.5 to 5 centimeters long; while those of *Bruguiera parviflora* and *Bruguiera cylindrica* are small and about a centimeter in length. The flowers of *Bruguiera conjugata* are typically red with the calyx divided into twelve to fifteen lobes; while the flowers of *Bruguiera sexangula* are usually yellow with the calyx divided into ten lobes. As the calyx-lobes of *Bruguiera* are persistent, the fruits of these two species can be readily distinguished from those of the other two species of the genus by the long calyx-lobes, while the two species themselves can be separated according to the number of the lobes of the calyx. *Bruguiera cylindrica* and *Bruguiera parviflora* can easily be distinguished by the fact that the inflorescences of *Bruguiera cylindrica* bear two or three flowers, while those of *Bruguiera parviflora* have two to five flowers. The petals of *Bruguiera parviflora* are yellow with a brown border at the tip and those of *Bruguiera cylindrica* white. The fruits of these two species are readily distinguished by the fact that in *Bruguiera cylin-*



PLATE XVIII. BRUGIERA CONJUGATA WITH FLOWERS.

*drica* the calyx-lobes are bent away from the tip of the fruit, while those of *Bruguiera parviflora* are erect.

*Key to the species.*

1. Flowers yellow or red, 2.5 to 5 centimeters long; seedlings more than 6 millimeters in diameter; inflorescences with one flower each.
2. Flowers usually red..... *Bruguiera conjugata*.
2. Flowers usually yellow..... *Bruguiera sexangula*.
1. Flowers greenish yellow, about 1 centimeter in length; seedlings less than 6 millimeters in diameter. Inflorescences with two to five flowers.
2. Sepals bent back from the apex of the fruit..... *Bruguiera cylindrica*.
2. Sepals erect on fruit, less than one-fourth the length of the ovary.

*Bruguiera parviflora*.

**BRUGUIERA CONJUGATA** (Linn.) Merr. and **B. SEXANGULA** (Lour.) Poir.

These species are very similar, the chief difference between the two being in the color of the flowers, red in the first case and yellow in the second. These are the largest trees among the true mangroves. Full-grown individuals are from 40 to 65 centimeters in diameter and from 18 to 23 meters in height. The trees have an erect habit and thick-ridged, very dark, almost black bark, which contains many large, brown, corky pustules. The inner bark is of much the same character and appearance as that of *bakáuan* and contains about the same or a slightly larger amount of tannin.

The wood is very much the same in structure and appearance as that of *bakáuan*, except that it is lighter red. At a short distance from the base of the trees and extending out to a distance often as great as 5 or 6 meters are many air roots or knees, which are formed by roots bending upward and may extend 45 centimeters into the air. The seedlings are stouter and blunter than in the other trees of the family. They germinate and grow to a length of 15 to 25 centimeters before dropping from the tree.

**BRUGUIERA CONJUGATA** (Linn.) Merr. (Plate XVIII). BUSAIN.

Local names: *Potótan* (Mindoro, Bataan, Tayabas, Negros, Leyte, Zamboanga, Basilan, and Cagayan); *busai-ing* (Tayabas); *bakáu* (Tinago Island and Zambales); *bakáuan* (Mindoro); *busi-ing* (Mindoro); *bakáo* (Negros); *busáin* or similar forms (Mindoro and Tayabas).

The leaves of *Bruguiera conjugata* are elliptic or elliptic-oblong, pointed at the tip, the base wedge-shaped. When dry the upper surface is shiny, the lower surface dull. The flowers occur singly in the axils of the leaves and are 3 to 4 centimeters in length and when fully opened slightly over 3 centimeters in breadth. The calyx is bell-shaped, leathery in texture and



PLATE XIX. BRUGUIERA SEXANGULA WITH FLOWERS.

cut for half its length into narrow pointed teeth, usually twelve to fifteen in number. The petals are slightly shorter than the calyx-lobes and equal to them in number, two-lobed at the apex and with two to four bristles at the point of each lobe, hairy at the base, otherwise smooth or nearly so. Opposite each petal are two stamens, which are shorter than the petals. Each alternate filament is short. The fruit is small; it is found in the bottom of the calyx tube and contains a single seed which germinates in situ, forming a cylindrical root 30 to 60 centimeters in length. *Bruguiera gymnorhiza* Lam. is a synonym of *B. conjugata* (Linn.) Merr.

**BRUGUIERA SEXANGULA** (Lour.) Poir. (Plates XIX, XX). POTÓTAN.

Local names: *Potótan* or *putútán* (Tayabas, Zamboanga, Mindoro, Masbate, Misamis, Cotabato, and Palawan); *tagasa* (Bataan); *busáin*, *busáing*, etc. (Mindoro, Tayabas, Lanao, and Zamboanga); *sagasa* (Cagayan); *álay* (Palawan); *lagásak* (Palau); *bakáuan* (Manila); *sagasak* (Palau Island); *langari* (Basilan); *potótan-babae* (Palawan and Bataan); *bakáuan-lalaki* (Bataan); *kalabayuan* (Bataan); *balinsaráyan* (Tayabas).

The leaves of *Bruguiera sexangula* are pointed at the tip, and wedge-shaped at the base; the upper surface is shining, the nerves faint; the lower surface is reddish-brown when dry, the veins are very faint or obsolete, but the midrib is prominent. The flowers are yellow, sometimes tinged with orange, and occur singly in the axils of the leaves. They are usually 3 to 4 centimeters in length and when fully opened about 2.5 centimeters in breadth. The calyx is similar to that of *Bruguiera conjugata*, but the lobes are usually only ten in number. The petals are about half the length of the calyx-lobes and deeply divided into two parts, with a stout bristle in the angle between the two narrow lobes, and sometimes with two bristles at the end of each lobe. The edges are densely clothed with stout white hairs. The fruit is similar to that of *Bruguiera conjugata*, except that the germinating root is shorter.

*Bruguiera eriopetala* W. & A. is a synonym of *Bruguiera sexangula* (Lour.) Poir.

**BRUGUIERA CYLINDRICA** (Linn.) Blume (Plates XXI, XXII). POTÓTAN-LALÁKI.

Local names: *Bakáuan* (Mindoro); *biús* (Cotabato); *busáin* (Mindoro); *hiñgáli* (Negros); *lañgarai* (Cotabato); *magtongóg* (Masbate); *potótan* and *potótan-lalaki* (Tayabas and Mindoro); *tañgal-babák* (Mindoro); *kalapínai* (Union); *buis* (Moro); *tañgálan* (Mindoro); *biuis* (Pangasinan); *magtāngúd* (Masbate); *biuas* (Bataan).

*Bruguiera cylindrica* has flowers intermediate in size between those of *Bruguiera conjugata* and *Bruguiera parviflora*. The tree is usually of low growth, otherwise it is much like *Bruguiera*



PLATE XX. BRUGUIERA SEXANGULA WITH IMMATURE FRUIT.  
161791—4



PLATE XXI. BRUGUIERA CYLINDRICA, FRUITS AND FLOWERS.



PLATE XXII. BRUGUIERA CYLINDRICA WITH FLOWERS.

*parviflora*. This species occurs in the Philippines in an exceedingly small amount. Swamps are frequently found which do not contain it, and it is usually of small size.

*Bruguiera cylindrica* has rather thin leaves. They are soft, 7 to 12 centimeters in length, shiny, and narrowed at both ends. The flowering stalks are found in the axils of the leaves; they are usually shorter than the petioles and bear two to three flowers. The flowers are greenish, about 1 centimeter long and slightly over a centimeter broad. The calyx is green and divided into seven or eight narrow fleshy lobes. The petals are white, equal in number with, but shorter than, the calyx-lobes. The apex of each petal is divided into two lobes; the margins have scanty white hairs outside; the apices are rounded and each is crowned with from three to five brown bristles, while one bristle is found in the angle between the two lobes. The stamens are sixteen in number and unequal in length. The germinating root is cylindrical and reaches a length of 15 to 20 centimeters before the seed falls from the tree. *Bruguiera caryophylloides* Blume. is a synonym of *Bruguiera cylindrica* (Linn.) Blume.

**BRUGUIERA PARVIFLORA** W. & A. (Plates XXIII, XXIV). LAÑGARAI.

Local names: *Potótan* (Tayabas, Cagayan, Zamboanga); *hañgálai* or *hañgarai* (Mindoro, Masbate, Leyte, Iloilo, Negros); *hñgálai* (Polillo); *lañgarai* or *lañgarí* (Zamboanga, Tayabas, Masbate, Negros, and Zambales); *bakáuan-laláki* (Batangas); *bubutigan*, *biosan* (Samar).

*Bruguiera parviflora* is a tall, slender tree which is often found in solid stands in the interior of the swamp. Trees 15 to 30 centimeters in diameter and 12 to 18 meters in height are full grown, but trees up to 55 centimeters in diameter are found. The bark is gray, hard, and thick, and has broad, smooth ridges. The air roots are similar to those of *Bruguiera conjugata* and *B. sexangula*, but usually smaller; the wood, except for being lighter in color, is also much like that of these two species.

The seedling is of the same color as the leaves, slender and nearly cylindrical. The roots of the seedling grow to about 10 or 12 centimeters in length before the seed drops from the tree.

The leaves of *Bruguiera parviflora* are yellowish green, 6 to 10 centimeters in length, and rather narrow, particularly at the base. The upper surface is shiny, the lower dull. The flowering shoots are in the axils of the leaves and bear two to five yellowish green flowers. The whole flowering shoot, including the flowers, is considerably longer than the petioles of the leaves. The flowers are about a centimeter in length and about 6 millimeters in breadth. The calyx tube is cylindrical and ends in eight pointed lobes about one-fourth the length of the calyx tube.



PLATE XXIII. BRUGUIERA PARVIFLORA WITH FLOWERS.

The petals are the same in number as the calyx-lobes but shorter. They are yellow with a dark brown border at the tip. They are two-lobed and each bears three or four hairs, while a single hair is found between two lobes; otherwise the petals are smooth. The stamens are sixteen in number and of unequal size; two are embraced by each petal.

#### Genus **CERIOPS**

The two species of *Ceriops*, *C. tagal* and *C. roxburghiana*, are known as tañgál. They are separated only by very minute floral characters. Tañgál is a small tree with rather smooth, light gray or brown bark, which is perforated in many places by dark-colored lenticels. Below the outer corky layer, there is more or less orange color. The bark contains a high percentage of tannin. The trunk flares at the base. A short distance from the trunk some of the roots bend upward to form small knees.

The sapwood is small in amount and scarcely distinct from the heartwood. The heartwood is very hard and heavy, orange red, changing on exposure to reddish brown. It gives an iridescent orange-red color to water. The grain is straight and the texture fine and dense, taking a smooth, almost polished surface under sharp tools. It does not check badly, but is somewhat liable to warp in seasoning and is not difficult to work except for its hardness. The wood is used for much the same purposes as that of *Rhizophora*.

The leaves are leathery in texture, opposite, and wider toward the apex than near the base. They are notched at the apex. The flowers are small and light greenish yellow. The calyx has five or six lobes. The petals, five or six in number, are inserted at the base of a ten- to twelve-lobed fleshy disk. There are ten to twelve stamens, whose stalks are inserted between the lobes of the disk. The style is short and the stigma simple. The seedlings are angled in cross section and may reach a length of about 35 centimeters before falling from the tree.

Tañgál is found near the mouths of tidal streams. Full-grown trees are from 15 to 40 centimeters in diameter and from 8 to 11 meters in height.

#### *Key to the species.*

Flowers few on an inflorescence, each with a short stalk; apex of petals with three to four club-shaped appendages..... *Ceriops tagal*.  
Flowers few on an inflorescence, without individual stalks; apex of petals lacerate, that is with a torn appearance..... *Ceriops roxburghiana*.

**CERIOPS TAGAL** (Perr.) C. B. Rob.

**TANĠÁL.**

Local names: *Tañgál* (Tagalog, Bisayan, Zambales, and Zamboanga); *tuñgód* (Bisaya in Negros); *tañghál* (Mindoro); *magtoñgód* (Mindoro);



PLATE XXIV. FRUIT OF BRUGUIERA PARVIFLORA.

*tañgál-lalaki* (Mindoro); *tuñgúd* (Jolo); *tongóg* (Masbate); *tagása* (Bataan); *pakat* (Palawan); *tonggui* (Culion); *tuñgóg* (Visayan); *rónṅon* (Zambales); *rúñṅon* (Pangasinan).

The leaves of *Ceriops tagal* are from 5.5 to 7 centimeters in length and from 2 to 4.5 centimeters in breadth; the petioles, from 2 to 3 centimeters in length. The flowers are about 6 millimeters long and are borne on short stalks. The calyx-lobes are oblong and somewhat blunt. The petals are oblong; the apex flat or notched and with three or more club-shaped appendages. Stamens ten, nearly as long as the petals.

*Ceriops candollearia* H. & A. is a synonym of *Ceriops tagal* (Perr.) C. B. Rob.

**CERIOPS ROXBURGHIANA** Arn. (Plates XXV, XXVI).

TañGÁL.

Local names: *Matañgál* (Bataan); *tañgál* (Tayabas and Camarines); *tuñgung* (Surigao); *bakáuan* (Bataan and Mindoro); *bulubadiáng* (Panay); *tuñgúg* (Negros).

*Ceriops roxburghiana* has leaves up to 11 centimeters in length and 6 in breadth, petioles 1.5 to 3 centimeters in length. The flowers are about 5 millimeters long and about 5 millimeters broad and do not have individual stalks. The five or six calyx-lobes are short and somewhat pointed. The petals are oblong, white when young, turning to brown; the apex notched or slightly flattened and with a torn appearance.

#### Genus RHIZOPHORA

Bakáuan is the name given to the species of *Rhizophora*. These make up a very large part of the swamp and are often the most conspicuous constituent of it.

These trees are distinguished from all others by their much-branched prop roots, which hold the trees up out of the water. This is perhaps the reason why the wood of these trees is usually sounder than that of others from the swamp. Besides the roots which come out from the base of the trunk, there are often large numbers of roots developed from the lower branches. The bark is very dark, almost black, coarsely ridged, and about 2 centimeters thick. It contains a high percentage of tannin.

The sapwood is yellow or whitish; the heartwood dark orange to reddish brown. The transition from sapwood to heartwood may be either gradual or abrupt. The wood is hard and heavy. The sapwood is 3 to 5 centimeters thick, and in old trees very sharply distinguished from the dark heartwood. The grain is straight and the texture fine and dense. It has a conspicuous



PLATE XXV. *CERIOPS ROXBURGHIANA* WITH FLOWERS.



PLATE XXVI. *CERIOPS ROXBURGHIANA* WITH FRUITS.



PLATE XXVII. RHIZOPHORA CANDELARIA, FRUIT AND OLD FLOWERS FROM WHICH PETALS HAVE FALLEN.

silver grain. Logs and large timbers are liable to check badly; but, if the wood is properly sawn and carefully stacked, it seasons with little warping and splitting. It is hard to saw, but not otherwise difficult to work. It lasts well in wet situations and is rarely attacked by insects.

The wood is used for salt water and foundation piling, mine timbers, house posts, furniture, and cabinet-work; if properly sawn and carefully seasoned, it would make an excellent flooring. On account of its shape, great strength, and durability when submerged in fresh water, it is specially recommended for submerged foundation piles.

The pear-shaped fruit is brown, with a granular or roughened surface. The seedling is long, spindle-shaped, and green. It grows downward and out of the fruit before the latter falls from the tree. The surface of the seedling is very smooth, except for occasional dark brown lenticels which project from the surface. The seedling grows to a length of 75 to 100 centimeters before dropping into the mud, where it promptly takes root. The maximum diameter attained by bakáuan is about 60 centimeters; exceptional trees sometimes have a clear length of 25 meters. The average dimensions are, however, much smaller than the figures just given. Where there is an abundance of light, the bole is usually crooked, low branched, and practically worthless except for firewood. In the interior of the forest bakáuan is fairly straight, round boled, and has a moderately spreading crown.

The calyx is four-lobed. The petals are four in number, and slightly shorter than the calyx-lobes.

The two species of *Rhizophora* are easily distinguished, either in flower or fruit. The inflorescence stalks of *Rhizophora candelaria* are very short, being shorter than the petioles, occur below the leaves, and each bears two flowers. The inflorescence stalks of *Rhizophora mucronata* are among the leaves, as long as the petioles, and each bears from three to seven flowers. The fruits of the two species are easily separated by the length of the stalks. All of these characters are shown plainly in the illustrations of the species.

*Key to the species.*

- Flowers below the leaves; inflorescences with two flowers; stalks of inflorescences shorter than the petioles..... *Rhizophora candelaria*.  
 Flowers among the leaves; inflorescences with three to seven flowers; stalk of inflorescences as long as the petioles..... *Rhizophora mucronata*.



PLATE XXVIII. RHIZOPHORA MUCRONATA, INFLORESCENCES AND FLOWER.

**RHIZOPHORA CANDELARIA** DC. (Plates I, XXVII). · BAKÁUAN-LALÁKI.

Local names: *Bakáuan* (Tagalog); *bakáu* (Visayan); *bakáuan-babáe* (Tagalog and Bisaya, Zamboanga); *uakátan* (Mindoro); *bakáuan-laláki* (Mindanao); *bakad* (Zambales); *bakhau* (Samar, Capiz); *bakau-laláki* (Pampanga); *bangkáu* (Davao).

The leaves of *Rhizophora candelaria* are 10 to 16 centimeters in length, leathery in texture, green and shiny, and oblong-elliptic in shape. The apex is pointed or ends in a thornlike prolongation of the midrib. The stalks of inflorescences are found in the axils of fallen leaves and are shorter than the petioles of the leaves. Two flowers are borne on each inflorescence stalk. The flowers are pale greenish yellow.

This species is usually known by the erroneous name *Rhizophora conjugata*.

**RHIZOPHORA MUCRONATA** Lam. (Plates XXVIII, XXIX). BAKÁUAN-BABÁE.

Local names: *Bakáuan* (Tagalog); *bakhao* (Surigao); *bakáu* (Negros); *bakáuan-laláki* (Zambales); *bakáuang-laláki* (Zamboanga); *bangkáu* (Tagalog in Tayabas).

The leaves of *Rhizophora mucronata* are leathery in texture, oblong-elliptic, shiny, and up to 16 centimeters in length. The apex of the leaf terminates in a slender, thornlike prolongation of the midrib. The inflorescence stalks are among the leaves. They are from 2.5 to 4 centimeters in length, about as long as the petioles of the leaves, forked at the apex, and bear from three to seven flowers. The flowers are white to cream color.

## Family 10, COMBRETACEAE

Genus **LUMNITZERA***Key to the species.*

Flowers scarlet ..... *Lumnitzera littorea*.  
Flowers white ..... *Lumnitzera racemosa*.

**LUMNITZERA LITTOREA** Voigt. (Plate XXX).

TABÁU.

Local names: *Batíng* or *baktíng* (Tawi-tawi, Jolo); *dalúru-babáe* (Tayabas); *sagása'* (Dinagat Island); *maóro* (Surigao); *colasiman* (Culion Island); *libáto* (Tayabas, Polillo, Palawan); *pantíng-pantíng* (Basilan); *kalapíní* (Zambales); *kulási* (Mindoro); *bulokbúlok* (Negros Occidental); *agnáia* (Zambales); *karífurug* (Cagayan); *anílái* (Mindoro); *papásil* (Tayabas); *magalolo* (Polillo); *santíng* (Moro and Tawi-tawi); *tabáu* (Capiz, Negros, Zamboanga, Sorsogon, Masbate); *dulokdúlok* (Masbate); *sala'sá* (Occidental Negros).

This species is a tall tree found along rivers in the swamps,



PLATE XXIX. RHIZOPHORA MUCRONATA WITH FRUIT.

and a smaller tree or shrub where conditions for growth are less favorable. It reaches a diameter of 50 centimeters and a height of 18 meters. The bark is gray when the tree is young and often nearly black when mature, coarsely furrowed, rather thick and corky. The air roots are few in number and similar to those of *Bruguiera conjugata*, *B. sexangula*, and *B. cylindrica*.

The wood has a distinct roselike odor when fresh. The sapwood and heartwood are not very different in color; the wood is pale brown, straight grained, dense and smooth, with a fine texture, and takes a silky finish under a sharp plane. It seasons well and is easy to work. It is used for piles, poles, house posts, ties, paving blocks, bridges, and wharves, general strong construction, ship planking and decks, handles, and cabinet-work.

The leaves are 5 to 8 centimeters long, alternate, very thick and fleshy, rounded at the apex and notched, and clustered toward the ends of the twigs. The petioles are very short. The flowers are bright scarlet and about 8 millimeters in length. They are borne in considerable numbers at the ends of branches. The calyx tubes terminate in five lobes. The petals are scarlet, five in number, and about 7 millimeters long. There are five to ten, but usually seven stamens, which are the same color and twice as long as the petals. The fruit is woody, elongated, about 2 centimeters long and 7 millimeters wide, narrowed at each end, crowned by a persistent calyx rim, and contains a single seed.

**LUMNITZERA RACEMOSA** Wild.

KULÁSI'.

Local names: *Tabán* (Iloilo, Tayabas); *sulási'* (Rizal, Manila); *kulási'* (Bataan).

This species differs from the last in being of much smaller size and in having white flowers. This tree grows in mud in the swamp or in sand at the edge of the swamp. The wood is like that of *Lumnitzera littorea*.

The leaves are fleshy, green, shiny, 2.5 to 7 centimeters in length, the apex rounded and notched, the base pointed, the petioles very short. The flowering shoots are borne in the axils of leaves and are from 2 to 6 centimeters long. The calyx is green, 5 to 6 millimeters long, with five short lobes. The petals are white, about 4 millimeters long, and five in number. The stamens are white, about as long as the petals, and five to ten in number. The fruit is woody, green, oblong, about 1.5 centimeters long, narrowed at both ends, crowned by the persistent calyx rim, and contains a single seed.



PLATE XXX. LUMNITZERA LITTOREA, FRUIT AND FLOWERS.

## Family 11, MYRTACEAE

## Genus OSBORNIA

OSBORNIA OCTODONTA F. Muell. (Plate XXXI).

TAWALIS.

Local names: *Tuawis* (Palawan); *tiwayos* (Masbate); *gunhun* (Basilan); *maligáng* (Polillo Island); *tawalis* (Tayabas, Camarines); *sagasá'* (Iloilo); *tabáu* (Negros); *duluk-dúluk* and *sagasá'* (Negros); *monotbonot* (Leyte); *kulási'* (Zamboanga); *tuanio* (Tayabas).

*Osbornia octodonta* is a small tree with a very crooked trunk. The bark is reddish brown and very shaggy, and is sometimes used in the caulking of boats. The wood is light grayish brown, fine grained, and exceedingly durable.

All parts of the plant are smooth except the flowers, which are hairy. The leaves are opposite, rounded at the tip, pointed at the base, about 4 centimeters long, and 1 to 2 centimeters wide. The flowers are white, less than a centimeter in length, without stalks, and are borne either singly or in groups of a few flowers either in the axils of the leaves or at the ends of branches. Petals are lacking. The calyx is bell-shaped and terminates in eight lobes. The fruit is included within the calyx tube and contains one or two seeds.

## Family 12, MYRSINACEAE

## Genus AEGICERAS

*Key to the species.*

Leaves up to 4.5 centimeters wide; flowers in rounded clusters, all of the flower stalks joined at about the same point..... *Aegiceras corniculatum*.

Leaves 3 centimeters wide or less; flowers in compound inflorescences. *Aegiceras floridum*.

AEGICERAS CORNICULATUM (Linn.) Blanco. (Plates XXXII-XXXIV).

SAGING-SÁGING.

Local names: *Timbambákis*, *pilápil*, *pagatpát*, *pipisík* (Bataan); *saging-ságing* (Capiz, Negros, Lanao, Surigao, Mindoro); *kindug-kindúg*, *sulasig*, *tinduk-tindúkan* (Tayabas); *dumanai* (Cagayan); *tindok-tindók* (Leyte, Tayabas); *tindók* (Mindoro); *tunduk-tundúkan* (Polillo Island); *batag-batág* (Zambales); *bulali* (Negros); *tayokón* (Surigao).

*Aegiceras corniculatum* is a small tree or shrub which is found along streams in the inner part of the swamp and, occasionally, on more or less sandy spots in the outer part of the swamp. The bark is dark brown. The tree rarely exceeds 8 meters in height and is usually much smaller.

The leaves are alternate, leathery, smooth, rounded and notched at the apex, somewhat pointed at the base, usually from 4 to 10 centimeters in length, and 2.5 to 6 centimeters wide; the



PLATE XXXI. OSBORNIA OCTODONTA WITH FRUITS.



PLATE XXXII. AEGICERAS CORNICULATUM WITH FLOWERS.



PLATE XXXIII. FLOWERS OF AEGICERAS CORNICULATUM.

midrib is slender; the petioles are usually about a centimeter or less in length. The flowers are fragrant and borne in rounded clusters, the bases of the stalks all rising from nearly the same point. The flower stalks are slender and 1 to 2 centimeters in length. The calyx has 5 lobes, which are leathery, twisted to the left and overlapping to the right, and about 6 millimeters long. The corolla is white and has a short tube about 6 millimeters long with five pointed lobes, which overlap to the right in the bud and are about as long as the tube. There are five stamens, which are inserted on the corolla tube and are longer than the corolla lobes. The fruit is shaped like a miniature banana except that it usually ends in a sharp point. It is up to 7 centimeters in length and contains a single, elongated seed which fills the cavity of the fruit.

**AEGICERAS FLORIDUM** R. and S. (Plate XXXV). TINDUKTINDUKAN.

This species is much less abundant than *Aegiceras corniculatum* and differs from it in having smaller leaves, which are 3 centimeters or less in width, and in having branched inflorescence stalks.

### Family 13, APOCYNACEAE

#### Genus **CERBERA**

**CERBERA MANGHAS** Linn. (Plate XXXVI).

BARAYBÁY.

Local names: *Buto-butó* (Surigao, Dinagat Island); *bayag-usá*, *pan-dakaki* (Camarines); *baraybáy* (Baler); *butá-butá* (Bataan), *bat-ano* (Camiguin Island); *kábi* (Zambales); *dítá* (Moros); *lipáta* (Palawan); *panabulón* (Negros); *duñgás* (Cotabato).

*Cerbera manghas* is usually a shrub, although it may sometimes grow into a small tree. It occurs in situations similar to *Excoecaria agallocha*. *Cerbera manghas* has milky sap like that of *Excoecaria*.

The leaves are shiny, narrowed at both ends, and about 20 centimeters long. The flowers are white, fragrant, about 5 centimeters in diameter, and occur on terminal branches. The calyx tube is short and ends in five lobes, which are spreading, pale green, pointed, and about 2 centimeters long. The corolla tube is slender, greenish white, large above, and about 4 centimeters long. The upper part of the corolla is spreading, about 5 centimeters in diameter, white with a purple center, and divided into five lobes. The fruit is smooth, green, rounded, and about 6 centimeters long.

*Cerbera odollam* Gaertn. is a synonym of *Cerbera manghas* Linn.



PLATE XXXIV. AEGICERAS CORNICULATUM WITH FRUITS.



PLATE XXXV. AEGICERAS FLORIDUM WITH IMMATURE FRUITS.



PLATE XXXVI. CERBERA MANGHAS, FLOWERS AND FRUIT.

## Family 14, VERBENACEAE

Genus *AVICENNIA*

Trees of *Avicennia* are distinguished from all others in the swamps by the lower surface of the leaves being light gray or white. This character is most nearly approached in *Heritiera*, the lower surfaces of the leaves of which have a silvery appearance.

*Key to the species.*

Tips of leaves usually somewhat rounded..... *Avicennia officinalis*.  
 Tips of leaves pointed..... *Avicennia alba*.

**AVICENNIA OFFICINALIS** Linn. (Plates XXXVII, XXXVIII). API-ÁPI.

Local names: *Miápi* (Samar, Leyte, Masbate); *api-ápi* (Capiz, Bataan, Davao, Zamboanga, Cotabato, Palawan, Mindoro); *kalapini mangit-it* (Zambales); *buñgálon* (Marinduque, Tayabas, Pangasinan, Zambales, Mindoro, Capiz, Iloilo, Camarines, and Negros); *kulási* (Cotabato); *kalapini* (Pangasinan, Bataan, and Zambales); *pipisíg* or *pipisík* (Tayabas, Camarines, Mindoro); *piápi* (Iloilo, Capiz, Agusan, Tayabas); *liñgóg* (Cagayan); *piksík* (Mindoro).

This species is a tree of the outer part of the swamp. The bark is usually light gray or brown and rather smooth but finely checked by small cracks. The air roots are numerous, small, 8 to 20 centimeters high, and conical. This species is of little value. In swamps where cutting has been excessive, and more valuable species removed, the latter are often largely replaced by *Avicennia officinalis*.

The wood is hard, heavy, brittle, but difficult to split, having an exceedingly crossed spiral grain. The sapwood is 4 to 6 centimeters thick, whitish, turning in drying to gray or light brown, in large trees sharply marked off from heartwood. The heartwood is purplish gray. The grain is very conspicuous from alternate bands of hard and soft tissue, very strongly crossed, often irregularly wavy. The texture of the hard tissue is extremely fine and dense; of the soft tissue, somewhat coarser. The wood seasons well, but the sapwood is liable to stain badly if not seasoned quickly. It is not difficult to work. The durability is said to be poor, but the wood is rarely attacked by beetles. It is used locally for rice mortars; is a favorite in some regions for smoking fish; a wood that for its peculiar color and attractive grain should find a good place in small cabinetwork; recommended for trial in creosoted paving blocks.

The leaves are leathery, opposite, dark green above, very pale and hairy beneath, usually somewhat rounded at the apex, narrow at the base, 5 to 10 centimeters long and 2.5 to 5 centimeters broad; midrib stout and very prominent. The flowers



PLATE XXXVII. AVICENNIA OFFICINALIS, FLOWERS AND IMMATURE FRUIT.

are small, without individual stalks, and are in small heads on stiff angular flowering stalks, which occur either two together in the axils of the upper leaves or several at the end of a branch. There are three to seven flowers in each head. The corolla is orange-yellow. The corolla tube is very short, cylindrical, and has four lobes. The lobes are 5 millimeters in length, hairy without, and nearly smooth within. The calyx has five lobes, which are 2 to 8 millimeters long, hairy on the margins; the lower part of the back hairy, the rest smooth. There are four stamens, which are inserted on the throat of the corolla and extend beyond the corolla. The fruit is a capsule, 2.5 to 4 centimeters long, and contains a single seed which completely fills the capsule.

**AVICENNIA ALBA** Blume.

API-ÁPI.

Local names: *Kachúchis* (Surigao); *piápi* (Misamis); *pundúg* (Cotabato)

This species is apparently less abundant than *Avicennia officinalis* and differs from it largely in inconspicuous floral characters. The wood appears to be identical with that of *Avicennia officinalis*.

The leaves are leathery, pointed at the apex, narrowed at the base, either smooth on both surfaces or with whitish hairs beneath, especially when young; 5 to 7 centimeters long, 2.5 to 5 centimeters broad. The midrib is prominent. The flowers, without individual stalks, grow either in small heads or in spikes. The calyx has segments, which are thick, 2.5 millimeters long, fringed with hair, and slightly hairy at the back near the base. The corolla tube is very short and sometimes almost lacking. It has four smooth pointed lobes, 2.5 millimeters long. There are four stamens inserted on the corolla throat. These do not reach to the end of the corolla. The fruit is a capsule 1 to 2 centimeters in length and contains one seed which completely fills the lower part of the capsule.

## Family 15, ACANTHACEAE

### Genus **ACANTHUS**

*Key to the species.*

Flowers blue; corolla about 4 centimeters long..... *Acanthus ilicifolius*.  
Flowers white; corolla about 2 centimeters long..... *Acanthus ebracteatus*.

**ACANTHUS ILICIFOLIUS** Linn. (Plate XXXIX).

DILIUÁRIU.

Local names: *Lagoilói* (Agusan); *gregorio* (Bisaya); *dagudri*, *galura*, *tindoi*, *tinlui* (Tagalog); *daluári* (Bataan); *santing-santing* (Moro); *duluáriu* (Mindoro).



PLATE XXXVIII. *AVICENNIA OFFICINALIS* WITH AIR ROOTS.

*Acanthus ilicifolius* is a shrub 0.5 to 1.5 meters high. It has prop roots. The leaves are opposite and up to 18 centimeters in length and 8 in breadth. They have very short petioles. The flowers are about 4 centimeters long, borne on spikes, and are surrounded by two bracts and a bracteole. The calyx is divided near the base into four parts, two of which are much longer than the other two. The fruit is a capsule from 2 to 2.5 centimeters long.

ACANTHUS EBRACTEATUS Vahl.

TIGBAU.

This species is also known by the same names as *Acanthus ilicifolius*. The flowers of *Acanthus ebracteatus* are surrounded by two bracts but no bracteole. The corolla is white and about 2 centimeters long. The calyx is shorter than in *Acanthus ilicifolius*. Otherwise the species is similar to *Acanthus ilicifolius*.

## Family 16, RUBIACEAE

### Genus SCYPHIPHORA

SCYPHIPHORA HYDROPHYLLACEA Gaertn. (Plate XL). NÍLAD.

Local names: *Arinaya* (Ilocos Norte); *landing* (Culion, Tayabas); *tugisak* (Cotabato); *balasiái* (Zambales); *kulási'* (Tayabas); *hanbulali*, *tabáu* (Negros); *sagasá* (Zamboanga); *nílad* or *nílar* (Tagalog).

*Scyphiphora hydrophyllacea* is a small tree growing along streams in the swamps. It has dark-colored bark. All parts of the plant except the inside of the corolla tube are without hairs.

The leaf blades are smooth, leathery, rounded at the apex, and pointed at the base, 4 to 10 centimeters long, and 2 to 5 centimeters wide. The petioles are usually 1 to 2 centimeters long. The flowers are small, white, often tinged with red, and borne in compact groups. The calyx is about 4 millimeters long. The calyx tube ends in four or five small teeth. The corolla tube is cylindrical, about as long as the calyx with four or five lobes which are about half as long as the tube. The fruit is somewhat cylindrical, with eight to ten grooves, and usually a little less than a centimeter in length.

## Family 17, COMPOSITAE

### Genus PLUCHEA

PLUCHEA INDICA Linn.

KALAPÍNI'.

Local names: *Banig-banig* (Moro); *kalapíni'* (Manila); *manzanilla* (Batangas); *lagúndi'-láte* (Zambales).

*Pluchea indica* is a small shrub 1 to 4 meters in height. The leaves are 1 to 7 centimeters long and widest toward the tip, which is slightly pointed; the base narrows to a point; the margin



PLATE XXXIX. ACANTHUS ILICIFOLIUS, FLOWERS AND FRUIT.

is toothed. The flowers are light blue and are in dense heads arranged in compact inflorescences at the ends of branches. The fruit is minute and crowned with white hairlike projections.

#### STANDS IN MANGROVE SWAMPS

The present condition of the mangrove swamps in the Philippines is very variable. In places close to centers of population, as in the immediate vicinity of Manila, Iloilo, and Cebu, the swamps have been so closely cut-over as to make them almost valueless. In many other places the most valuable trees have been largely removed, in other areas the swamps yield a large quantity of good material, and still others are practically untouched. The largest remaining virgin swamps in the Islands are probably in Palawan and Mindanao, although in both of these islands a considerable amount of cutting and bark collecting has been carried on.

A careful study of the swamps near Port Banga, Mindanao, has been made by Dr. H. N. Whitford and Forester W. I. Hutchinson. The following extracts from their report describes this forest:

The mangle forests of the Port Banga tract cover an area of 2,463 hectares (6,086 acres). The largest continuous body of swamp, varying in width from 0.5 to 2 kilometers (0.31 to 1.42 miles), extends from the head of Balon Bay northward to the Baluan River. Scattered areas, some of considerable extent, also occur near the Tungauan River, and in Ticbucay Bay and Port Banga.

Light cuttings have been made in these swamps for many years, and since 1902 certain situations have been heavily culled for posts and poles. Tanbark has also been extensively exploited, many areas being practically stripped of Tangal, the species from which the bark is obtained.

The mangle forest is made up of a dense stand of small and medium-sized trees, many of which are raised on stilt roots from 1 to 3 meters (3 to 10 feet) above the ground. The characteristic species of the stand are Pagatpat, Bakauan, and Pototan. In certain localities Piagau and Langarai form pure stands, to the practical exclusion of all other trees. Tangal and several minor species occur scattered throughout all the swamps.

The soil is soft, black mud of unknown depth. Underbrush and litter are entirely absent. The only method of travel through many of the swamps is by climbing along on the stilt roots of the trees.

In the area surveyed, Pagatpat and Bacauan formed over 90 per cent of the stand. The average diameter of all trees over 40 cm. (16 inches) is 47 cm. (18 inches). The largest tree is Pagatpat, which reaches a maximum diameter of 80 centimeters (31 inches) or more, with a maximum clear length of 17.50 meters (57 feet). The clear length of Bakauan almost equals Pagatpat, and that of Pototan exceeds it, but the greater percentage of these species falls below 40 centimeters (16 inches) in diameter.



PLATE XL. SCYPHIPHORA HYDROPHYLLACEA, FRUITS AND FLOWERS.

Where the stand is dense, the trees are tall, straight, and clean-boled. In open situations, they are low-branched and crooked. Bakauan is the only important swamp tree with stilt roots.

TABLE I.—*Stand table for 1 hectare of mangrove swamp forest near Port Banga, Mindanao. Average of 6.25 hectares.*

[Data from H. N. Whitford and W. I. Hutchinson.]

AVERAGE NUMBER OF TREES 30 CENTIMETERS AND OVER IN DIAMETER.

Diameter at breast high or above buttresses.	Bakauan.	Pagatpat.	Tangal.	Pototan.	Total.	Other species.	Grand total.
<i>cm.</i>							
30 -----	72.96	8.00	6.08	0.80	87.84	1.12	88.96
40 -----	22.24	10.88	2.24	0.48	35.84	0.64	36.48
50 -----	3.04	7.84	0.32	0.16	11.36	0.32	11.68
60 -----	0.32	5.44	0.32	0.32	6.40	-----	6.40
70 -----	-----	2.56	-----	-----	2.56	-----	2.56
80 -----	-----	2.08	-----	-----	2.08	-----	2.08
90 -----	-----	0.48	-----	-----	0.48	-----	0.48
100 -----	-----	0.32	-----	-----	0.32	-----	0.32
Total -----	98.56	37.60	8.96	1.76	146.88	2.08	148.96
Per cent -----	66.17	25.24	6.01	1.18	98.60	1.40	100.00

AVERAGE NUMBER OF TREES 40 CENTIMETERS AND OVER IN DIAMETER.

Per hectare -----	25.60	29.60	2.88	0.96	59.04	0.96	60
Per cent -----	42.67	49.32	4.80	1.60	98.40	1.60	100

AVERAGE AND MAXIMUM DIAMETER OF COMMERCIAL TREES.

Species.	Average diameter breast high or above buttresses.		Maximum diameter breast high or above buttresses.	Number of trees measured.
	Trees 30 centimeters and over.	Trees 40 centimeters and over.		
	<i>cm.</i>	<i>cm.</i>	<i>cm.</i>	
Bakauan -----	32.97	41.44	60	616
Pagatpat -----	48.26	53.19	100	235
Pototan -----	40.00	48.33	60	11
Tangal -----	34.28	43.33	60	56
Average -----	38.88	46.57	-----	-----

Table I shows the number of trees over 30 centimeters in diameter according to species and diameter classes of 10 centimeters. In Table II are shown the number of poles 6 to 15 centimeters and 16 to 25 centimeters in diameter. These figures were obtained in a virgin stand.

TABLE II.—*Stand of poles on one hectare in mangrove swamp forest, Port Banga area, Mindanao. Average of 6.25 hectares.*

[Data from H. N. Whitford and W. I. Hutchinson.]

Pole class.	Average number of poles per hectare.								Average stand per acre.
	Bakauan.	Tangal.	Pagatpat.	Pototan.	Total.	Miscellaneous species.	Grand total.	Per cent.	
Small, 6 to 15 cm. diameter .....	57.75	7.52	5.44	0.64	71.35	1.92	73.27	43.5	29.65
Large, 16 to 25 cm. diameter .....	74.88	11.04	7.04	1.12	94.08	1.12	95.20	56.5	38.53
Total .....	132.63	18.56	12.48	1.76	165.43	3.04	168.47	100.0	68.18
Per cent .....	78.73	11.02	7.41	1.04	98.20	1.80	100.00	-----	-----

Dr. F. W. Foxworthy has found stands of from 300 to 650 cubic meters per hectare in large swamps in Mindanao.

Tables III to V, taken from a report by Ranger Vicente Castillo on a virgin mangrove swamp on Basiad Bay in Tayabas Province, give a good idea of the original composition of a mangrove swamp. In these tables cords are calculated by allowing 30 per cent for air space in stacking. One cord is the equivalent of 3.62 cubic meters.

An examination of these tables shows that the stand of timber in a virgin forest is comparatively heavy.

TABLE III.—*Stand of firewood 10 centimeters and over in diameter on 2.3 hectares. Survey applicable to 440 hectares between Mapinghil and Poctol Point, Capalonga, Tayabas, Luzon.*

[Data from report by Ranger Vicente Castillo.]

Species.	Trees.	Volume.		Species by number of trees.	Species by volume.
		cu. m.	Cords.		
Busain .....	816	146.22	58.49	45.0	55.6
Langarai .....	620	73.33	29.33	34.2	27.9
Bakauan .....	257	36.66	14.66	14.2	13.9
Tabigi .....	74	3.90	1.56	4.0	1.5
Tangal .....	46	2.21	0.88	2.5	0.8
Pagatpat .....	2	0.55	0.22	0.1	0.2
Total .....	1,815	262.87	105.14	-----	-----
Stand per hectare .....	789	114.29	45.71	-----	-----

TABLE III.—Stand of firewood 10 centimeters and over, etc.—Continued.

NUMBER OF TREES AND VOLUME BY DIAMETER CLASSES.								
Species.	Diameter class in centimeters							
	10.		15.		20.		25.	
	Trees.	Volume.	Trees.	Volume.	Trees.	Volume.	Trees.	Volume.
		<i>cu. m.</i>		<i>cu. m.</i>		<i>cu. m.</i>		<i>cu. m.</i>
Busain -----	100	3.55	124	10.11	267	42.84	237	58.00
Langarai -----	273	17.17	236	30.76	86	18.15	25	7.25
Bakauan -----	60	1.58	49	3.54	71	10.04	67	15.40
Tabigi -----	49	1.61	19	1.45	6	0.84		
Tangal -----	29	0.78	13	0.91	4	0.52		
Pagatpat -----							2	0.55
Total -----	511	24.69	441	46.77	434	72.39	331	81.20

Species.	Diameter class in centimeters.					
	30.		35.		40.	
	Trees.	Volume.	Trees.	Volume.	Trees.	Volume.
		<i>cu. m.</i>		<i>cu. m.</i>		<i>cu. m.</i>
Busain -----	72	24.17	14	6.55	2	1.00
Langarai -----						
Bakauan -----	8	5.04	2	1.06		
Tabigi -----						
Tangal -----						
Pagatpat -----						
Total -----	80	29.21	16	7.61	2	1.00

In Table III busain (*Bruguiera conjugata*) is represented by more individuals and about twice the volume of any other species, and contains more than half the total volume. Langarai (*Bruguiera parviflora*) is the next most numerous species and after busain is represented by a larger volume than any other species. These two species of *Bruguiera* compose 83.5 per cent of the total volume of the stand. Bakauan (*Rhizophora* spp.) contains 13.9 per cent of the total stand. The other species are present in small quantities. The greatest volume is found within the 20- and 25-centimeter diameter classes, these classes composing 58 per cent of the total volume.



Fig. 1. Pototan tree, along seacoast at low tide.



Fig. 2. Pototan; lower trunk and roots.

PLATE XLI.

TABLE IV.—*Stand of firewood 10 centimeters and over in diameter on 3.8 hectares, between Mapinghil Point and Basiad River, Capalonga, Tayabas, Luzon. Survey applicable to 890 hectares.*

[Data from report by Ranger Vicente Castillo.]

Species.	Trees.	Volume.		Species by number of trees.	Species by volume.
		cu. m.	Cords.		
Tangal .....	990	61.19	24.48	41.37	33.06
Bakauan .....	572	50.99	20.40	23.90	27.55
Busain .....	358	36.08	14.43	14.96	19.49
Langarai .....	456	33.46	13.38	19.06	18.08
Pagatpat .....	6	2.28	0.91	0.25	1.23
Tabigi .....	11	1.08	0.43	0.46	0.58
Total .....	2,393	185.08	74.03	-----	-----
Stand per hectare .....	629	48.71	19.48	-----	-----

NUMBER OF TREES AND VOLUME BY DIAMETER CLASSES IN CENTIMETERS.

Species.	Diameter class in centimeters.							
	10.		15.		20.		25.	
	Trees.	Volume.	Trees.	Volume.	Trees.	Volume.	Trees.	Volume.
		cu. m.		cu. m.		cu. m.		cu. m.
Tangal .....	549	19.28	369	32.05	72	9.86		
Bakauan .....	211	6.49	212	15.19	81	11.46	60	15.10
Busain .....	92	2.85	121	9.08	109	15.88	26	5.40
Langarai .....	243	10.80	183	17.45	30	5.21		
Pagatpat .....					2	.35		
Tabigi .....	3	0.24	5	0.31	1	0.13	2	0.40
Total .....	1,098	39.66	890	74.08	295	42.89	88	20.90

Species.	Diameter class in centimeters.					
	30.		35.		40.	
	Trees.	Volume.	Trees.	Volume.	Trees.	Volume.
		cu. m.		cu. m.		cu. m.
Tangal .....						
Bakauan .....	4	1.19	4	1.56		
Busain .....	10	2.87				
Langarai .....						
Pagatpat .....	2	0.70	1	0.48	1	0.75
Tabigi .....						
Total .....	16	4.76	5	2.04	1	0.75

In Table IV tañgal (*Ceriops roxburghiana*) is the most numerous species and is represented by the largest volume. Bakauan (*Rhizophora* spp.) ranks next to tañgal, while busain (*Bruguiera conjugata*) and langarai (*Bruguiera parviflora*) are third and fourth, respectively. The other two species present occur in small quantities. In this table the largest percentage of volume is the 15-centimeter diameter class. In both Tables III and IV the number of individuals is greatest in the smallest diameter class and decreases in the larger classes.

TABLE V.—Stand of firewood 10 centimeters and over in diameter on 3 hectares, between Basiad and Angas Rivers, Calauag, Tayabas, Luzon. Survey applicable to 720 hectares.

[Data from report by Ranger Vicente Castillo.]

Species.	Trees.	Volume.		Species by number of trees.	Species by volume.
		cu. m.	Cords.	Per cent.	Per cent.
Bakauan .....	940	259.00	103.60	39.46	54.23
Langarai .....	1,002	150.52	60.21	42.07	31.51
Busain .....	246	32.63	13.05	10.33	6.83
Pagatpat .....	105	30.29	12.12	4.41	6.34
Tangal .....	82	4.49	1.79	3.44	0.94
Tabigi .....	7	0.70	0.28	0.29	0.15
Total .....	2,382	477.63	191.05	100.00	100.00
Stand per hectare .....	794	159.21	63.68		

NUMBER OF TREES AND VOLUME BY DIAMETER CLASSES IN CENTIMETERS.

Species.	Diameter class in centimeters.							
	10.		15.		20.		25.	
	Trees.	Volume.	Trees.	Volume.	Trees.	Volume.	Trees.	Volume.
		cu. m.		cu. m.		cu. m.		cu. m.
Bakauan .....	121	4.90	176	19.93	206	47.69	209	72.73
Langarai .....	485	30.64	281	42.53	172	46.18	59	27.91
Busain .....	104	5.48	74	6.97	32	5.96	23	6.81
Pagatpat .....	1	0.06	13	1.50	26	6.17	52	10.14
Tangal .....	54	1.79	26	2.10			2	0.60
Tabigi .....	3	0.09			4	0.61		
Total .....	768	42.96	570	73.03	440	106.61	345	118.19

TABLE V.—Stand of firewood 10 centimeters and over, etc.—Continued.

Species.	Diameter class in centimeters.					
	30.		35.		40.	
	Trees.	Volume.	Trees.	Volume.	Trees.	Volume.
		cu. m.		cu. m.		cu. m.
Bakauan .....	146	47.06	53	38.59	29	28.10
Langarai .....	5	3.26				
Busain .....	5	2.28	2	1.35	6	3.78
Pagatpat .....	4	2.77	1	0.96	8	8.69
Tangal .....						
Tabigi .....						
Total .....	160	55.37	56	40.90	43	40.57

In Table V, bakauan (*Rhizophora* spp.) is represented by the largest volume, but *Bruguiera parviflora*, by the greatest number of individuals. Langarai (*Bruguiera parviflora*) ranks next to bakauan (*Rhizophora* spp.) in volume, these two trees composing 86 per cent of the total volume. In this table the greatest percentage of volume is contained in the 20- and 25-centimeter diameter classes.

Forester Rafael Medina has made a valuation survey of 3 hectares between Catubig and Laoang in the mangrove swamps of Samar, to show how much merchantable saw timber over 40 centimeters in diameter can be taken from the mangrove swamps in that region. The results are given in Table VI. There was

TABLE VI.—Stand of timber 40 centimeters and over in diameter on 3 hectares between Catubig and Laoang, Samar.

[Data from report by Forester Rafael Medina.]

Species.	Per cent of each species by number of trees.	Trees.	Logs.	Average number of logs per tree.	Volume.		Average volume per tree.	
					cu. m.	bd. ft.	cu. m.	bd. ft.
Api-api .....	49.04	741	741	1	31.28	7,820.0	0.042	10.5
Bakauan .....	23.69	358	358	1	17.19	4,297.5	0.048	12.0
Busain .....	16.61	251	251	1	9.33	2,332.5	0.037	9.3
Tabigi .....	8.67	131	131	1	8.20	2,050.0	0.063	15.6
Tangal .....	1.99	30	30	1	1.10	275.0	0.037	9.2
Total .....	100	1,511	1,511		67.10	16,775.0	<sup>a</sup> 0.045	<sup>a</sup> 11.3
Per hectare .....		504	504		22.37	5,592.0		

<sup>a</sup> Average.



Fig. 2. Mangrove swamp. Bakauan rajitas in foreground.



Fig. 1. Mangrove swamp. Stumps of Ceriops in foreground. Trees of Rhizophora and Bruguiera.

PLATE XLII.

an average volume of 22.37 cubic meters in trees more than 40 centimeters in diameter. No trees produce on the average more than one log 5 meters in length. The most numerous tree was api-api (*Avicennia*), and the next was bakauan (*Rhizophora* spp.). The third most numerous species was busain (*Bruguiera sexangula*). The wood of api-api (*Avicennia*) is of comparatively little value, but is extensively used as firewood. That of the other species is very valuable.

Forester Medina has also made valuation surveys of other stands in Samar. The results are given in Tables VII to XI. In all of these tables, bakauan (*Rhizophora* spp.) is the most numerous tree. The second most numerous is api-api (*Avicennia*). This species, however, is very much less numerous than bakauan (*Rhizophora* spp.) and is represented by a much smaller volume. In Table VIII, langarai (*Bruguiera parviflora*) ranks next to bakauan (*Rhizophora* spp.) and api-api (*Avicennia*) third. The average volume per hectare in the different areas varies from 13.77 to 120.87 cubic meters. These tables represent swamps which have been used to some extent for the collection of firewood.

TABLE VII.—Stand of firewood 5 centimeters and over in diameter, between Pinamacdan River and Matnog Creek, Samar. Valuation survey taken on 6.35 hectares. Applicable to 2,710 hectares.

[Data from report by Forester Rafael Medina.]

Species.	Per cent of each spe- cies by number of trees.	Trees.	Logs.	Average number of logs per tree.	Volume.	
					cu. m.	Cords.
Bakauan .....	70.02	1,009	3,088	3.1	68.63	27.45
Api-api .....	13.88	200	449	2.2	9.78	3.91
Pagatpat .....	9.58	138	249	1.8	3.64	1.45
Pototan .....	2.08	30	94	3.1	1.84	0.74
Langarai .....	2.29	33	125	3.8	1.60	0.64
Tabigi .....	1.66	24	59	2.5	1.50	0.60
Tabau .....	0.21	3	13	4.3	0.22	0.09
Tangal .....	0.28	4	7	1.8	0.20	0.08
Total .....	100.00	1,441	4,084	-----	87.41	34.96
Stand per hectare .....	-----	227	643	-----	13.77	5.50

TABLE VII.—*Stand of firewood 5 centimeters and over, etc.*—Continued.

## NUMBER OF LOGS BY DIAMETER CLASSES.

Species.	Diameter class in centimeters.		
	5-10.	10-20.	20-30.
Bakauan .....	1, 152	1, 611	325
Api-api .....	199	188	62
Pagatpat .....	146	103	-----
Pototan .....	48	43	3
Langarai .....	95	27	3
Tabigi .....	14	38	7
Tabau .....	8	5	-----
Tangal .....	-----	7	-----
Total .....	1, 662	2, 022	400

TABLE VIII.—*Stand of firewood 5 centimeters and over in diameter, between Motiong Creek and Pinamacdan River, Samar. Valuation survey taken on 9.05 hectares. Applicable to 3,110 hectares.*

[Data from report by Forester Rafael Medina.]

Species.	Per cent of each species by number of trees.	Trees.	Logs.	Average number of logs per tree.	Volume.	
					cu. m.	Cords.
Bakauan .....	50.93	3, 988	11, 879	3. 0	597. 31	238. 92
Langarai .....	27. 19	2, 129	7, 086	3. 3	350. 29	140. 12
Api-api .....	10. 38	813	2, 066	2. 5	64. 97	25. 99
Pagatpat .....	4. 23	331	926	2. 8	45. 72	18. 29
Tabigi .....	6. 47	507	992	1. 9	27. 90	11. 16
Dungon-late .....	0. 49	39	105	2. 7	6. 15	2. 46
Pototan .....	0. 22	17	38	2. 2	1. 35	0. 54
Tabau .....	0. 09	7	16	2. 3	0. 22	0. 09
Total .....	100. 00	7, 831	23, 108	-----	1, 093. 91	437. 57
Stand per hectare .....	-----	865	2, 553	-----	120. 87	48. 35

## NUMBER OF LOGS BY DIAMETER CLASSES.

Species.	Diameter class in centimeters.			
	10-20.	20-30.	30-40.	40-50.
Bakauan .....	3, 817	3, 155	2, 347	2, 560
Langarai .....	2, 347	1, 800	1, 357	1, 582
Api-api .....	1, 080	545	303	138
Pagatpat .....	236	258	116	316
Tabigi .....	491	332	147	22
Dungon-late .....	34	19	27	25
Pototan .....	6	5	10	17
Tabau .....	12	4	-----	-----
Total .....	8, 023	6, 118	4, 307	4, 660

TABLE IX.—Stand of firewood 5 centimeters and over in diameter, between Dapdap River and Motiong Creek, Samar. Valuation survey taken on 14 hectares. Applicable to 1,080 hectares.

[Data from report by Forester Rafael Medina.]

Species.	Per cent of each species by number of trees.	Trees.	Logs.	Average number of logs per tree.	Volume.	
					cu. m.	Cords.
Bakauan .....	56.84	4,099	9,259	2.3	472.59	189.04
Api-api .....	25.02	1,804	4,250	2.4	144.34	57.74
Pagatpat .....	6.74	486	1,052	2.2	53.23	21.29
Langarai .....	3.49	252	808	3.2	39.74	15.90
Dungon-late .....	3.01	217	547	2.5	29.83	11.93
Pototan .....	2.09	151	346	2.3	20.30	8.12
Tabigi .....	2.32	167	323	1.9	18.94	7.58
Tangal .....	0.49	35	49	1.4	2.15	0.86
Total .....	100.00	7,211	16,634	-----	781.12	312.46
Stand per hectare .....	-----	515	1,188	-----	55.79	22.32

NUMBER OF LOGS BY DIAMETER CLASSES.

Species.	Diameter class in centimeters.			
	10-20.	20-30.	30-40.	40-50.
Bakauan .....	2,721	1,858	1,893	2,787
Api-api .....	2,388	936	465	461
Pagatpat .....	393	191	241	227
Langarai .....	298	227	165	118
Dungon-late .....	169	148	91	139
Pototan .....	95	72	85	94
Tabigi .....	121	51	61	90
Tangal .....	28	7	5	9
Total .....	6,213	3,490	3,006	3,925

TABLE X.—Stand of firewood 5 centimeters and over in diameter, between Carayman or Bongon River and Dapdap River, Samar. Valuation survey taken on 11.5 hectares. Applicable to 4,360 heetares.

[Data from report by Forester Rafael Medina.]

Species.	Per cent of each species by number of trees.	Trees.	Logs.	Average number of logs per tree.	Volume.	
					cu. m.	Cords.
Bakauan.....	63.09	2,748	6,202	2.2	335.47	134.19
Api-api.....	15.15	660	1,334	2.0	74.35	29.74
Langarai.....	8.10	353	1,070	3.0	67.77	27.11
Tabigi.....	5.26	229	505	2.2	60.14	24.06
Dungon-late.....	3.67	160	364	2.3	26.49	10.60
Pagatpat.....	3.67	160	401	2.5	26.41	10.56
Pototan.....	1.06	46	147	3.2	11.82	4.73
Total.....	100.00	4,356	10,023		602.45	240.99
Standard per hectare.....		379	872		52.38	20.96

NUMBER OF LOGS BY DIAMETER CLASSES.

Species.	Diameter class in centimeters.							
	10-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	80-90.
Bakauan.....	2,058	1,445	1,155	1,544				
Api-api.....	401	315	260	358				
Langarai.....	136	365	296	273				
Tabigi.....	57	135	129	135	9	7	7	26
Dungon-late.....	75	70	70	149				
Pagatpat.....	89	89	91	132				
Pototan.....	14	18	60	55				
Total.....	2,830	2,437	2,061	2,646	9	7	7	26

TABLE XI.—Stand of firewood 5 centimeters and over in diameter, between Barrio Peña and Carayman or Bongon River, Samar. Valuation survey taken on 1 hectare. Applicable to 300 hectares.

[Data from report by Forester Rafael Medina.]

Species.	Per cent of each species by number of trees.	Trees.	Logs.	Average number of logs per tree.	Volume.	
					cu. m.	Cords.
Bakauan .....	55.77	266	619	2.3	33.83	13.53
Api-api .....	24.74	118	195	1.6	11.96	4.78
Pagatpat .....	9.22	44	129	2.9	6.76	2.70
Tabigi .....	8.38	40	88	2.2	6.31	2.52
Dungon-late .....	1.89	9	18	2.0	1.32	0.53
Total .....	100.00	477	1,049	-----	60.18	24.06

NUMBER OF LOGS BY DIAMETER CLASSES.				
Species.	Diameter class in centimeters.			
	10-20.	20-30.	30-40.	40-50.
Bakauan .....	198	150	96	175
Api-api .....	53	60	26	56
Pagatpat .....	39	43	15	32
Tabigi .....	15	15	27	31
Dungon-late .....	4	2	6	6
Total .....	309	270	170	300

#### SWAMP CULTIVATION IN MANILA BAY

Cultivated swamps are found in the whole region around the upper part of Manila Bay, from Malabon on the east to Balanga on the west side; here, the virgin mangle has long since disappeared. The extent of the area covered by this cultivation has not been determined; but, in places, it extends 20 or more kilometers inland from the bay. Extensive reports on the cultivation of bakauan (*Rhizophora* spp.) in the above region have been made by Dr. F. W. Foxworthy and Ranger De Mesa. The following information is taken from their reports:

Nipa and bakauan are planted extensively in solid stands, but there is little planting of other swamp species.

Hundreds, and may be thousands, of hectares are planted to bakauan, which is grown for firewood, and sold principally in the Manila market, this wood being preferred to almost all others for fuel. The Manila supply is inadequate, as is indicated by the remarkably complete utilization of the swamps in the vicinity, and by the use of other and inferior species.

No records seem to exist as to how, when, and where bakauan was first cultivated, but it is safe to say that the present planting methods have been in use for at least three generations. An evident reason for the cultivation is the large agricultural population on the level lands of Pampanga Province and the accessibility of the Manila market.

In the municipalities of Macabebe, Guagua, Lubao, Sexmoan, and Orani there are a number of barrios along the rivers which have a population that divides its labor among the fishing, bakauan, and nipa industries.

#### PLANTING AND CULTIVATION

The land chosen for planting bakauan is brackish or salt swamp, at or near the edge of a river in places which are affected by the tide. Nipa and bakauan are often planted in the same kind of mud. Very soft muddy soil is said to be the best for bakauan; and on such soil it makes its most rapid growth. On comparatively firm mud, it grows far more slowly, sometimes requiring much more than twice as long to produce a crop as when grown on the very soft mud. Freshly deposited soft mud at the edge of a stream, even though the strip may be no more than 2 meters in width, is eagerly appropriated for new planting.

The unit of area used in the mangrove cultivation is the "luang," which is 279.56 square meters. There are thus 35.77 luangs in 1 hectare.

If the ground which is to be planted has not been in cultivation for some time, it is covered with a dense tangle of low shrubs and vines. These are, for the most part, the low shrubby diliuariu (*Acanthus ilicifolius* L.); the spiny, woody vine known as sapinit [*Caesalpinia nuga* (L.) Ait.]; and several small, low-growing vines.

The land must be thoroughly cleared before planting. This is a difficult task and usually costs 2 pesos per luang, sometimes 2.50 pesos per luang. This would mean the work of two men for about two days. The clearing consists in cutting off the brush, pulling up or digging up the roots, if this is possible, and filling and leveling crab holes.

Clearing is reduced to a minimum by promptly replanting cut-over areas. After bakauan has been harvested, the ground may be left idle for from four months to a year, or until the bark on the roots is evidently rotten. The area can then be replanted without any new clearing being necessary.

The seedlings are frequently gathered from special seed trees which are left for this purpose. Often low-growing or dwarf

trees near the edge of the stream are selected for the production of seed, as it is easier to collect seed from small than from large trees. This results in the use of rather small seedlings.

These are gathered at a cost of from 2 to 3 pesos per thousand. The higher price is given for prompt delivery and when cash payment is made. The smaller sum is paid when the money is given as an advance, several months before the performance of the work. The advance-payment method seems to be the one in commoner use. In some places, bakauan-lalaki seedlings are paid for at the rate of 2 or 3 pesos per thousand and bakauan-babae at 3 or 4 pesos per thousand. The bakauan-lalaki seedlings are smaller and more numerous and are, therefore, easier to collect than those of bakauan-babae. If the seedlings were placed 100 centimeters apart, 10,000 would be required to plant a hectare. If they were only 20 centimeters apart, 250,000 would be required.

After gathering, the seedlings are placed in a shady place and allowed to wilt for about two weeks. This is said to render them resistant to the attacks of crabs and other marine animals, which would eat them if they were planted perfectly fresh.

The principal planting season appears to be from May to August. May seems to be considered a less desirable month for planting than are the others, as the seedlings are said to be rather small during that month.

In planting, the seedlings are simply shoved a short distance into the mud, so that they will stand erect. They are spaced 40 to 100 centimeters apart. In some of the places visited, the seedlings were as close together as 20 centimeters. The most usual spacing seemed to be from 40 to 60 centimeters.

The planting may be done very rapidly, as a man can go almost at a run and plant two luangs or more per day. From 50 centavos to 1.20 pesos are paid for the planting of 10,000 plants.

The young plants are killed, if they are submerged for as long as three days; or if there is a flood while the plants are young, the excess of fresh water will kill many.

Young plantations at the edge of the river are protected from damage from floating objects by a fence of branches stuck in the mud or by a planted hedge of pagatpat (*Sonneratia* spp.). Sometimes a line of older bakauan trees is left to protect a new plantation. Bakauan-babae is usually planted along the edge next the stream, while bakauan-lalaki makes up most of the stand back of the bakauan-babae.

After the first year, it is customary to replant any blank spaces left by the death or destruction of any of the stand.

Cultivation consists principally in keeping the plantation clear of vines. It is said that it is sometimes necessary to cut out the vines each year. Usually there is very little of this to do; and, in many cases, there is no occasion to do it at all. The cost of this weeding is hard to estimate, because the man who does the work usually devotes only a part of his time to it. A man is able to do all the weeding for a large plantation, guard the plantation from thieves, and still have a considerable part of his time to spend in fishing. It seems that the cost of weeding is never a large item.

In some cases, where it is considered that the plants are too far apart, the terminal bud is split during the second year. This is said to cause the plants to form two or more trunks, thus filling up the space more completely.

During the first year, a plant produces from two to four pairs of leaves and does not grow much more than half a meter in height. At this time rather fleshy underground roots are formed and the whole plant is more herbaceous than woody in texture. In the second year the plant begins to branch at the top and to send out prop roots, while the stem become partly woody. During the third year the plant becomes stout and woody, while in succeeding years it makes height growth and thickens more symmetrically.

With the very close planting which is the rule, the plants grow very slender and straight. The dense shade produced, in time, causes self-pruning. Self-pruning is regarded as indicating that the bakauan is ready for cutting. Self-pruning takes place seven to twelve or more years after planting, according to the character of the soil.

Only small firewood sizes are grown. Material large enough for rajas<sup>1</sup> is very rarely seen.

Hacenderos all agree that the individual tree will grow more rapidly and will reach a larger size, if it is given more room. They feel confident, however, that they would lose money if they planted at a greater interval; as they would have fewer trees. However, planting at an interval at least twice as wide as is commonly used would probably be a profitable experiment.

Bakauan-babae is said to grow more rapidly than does baka-

---

<sup>1</sup> Rajas are sticks of firewoods split from sections of trunks 8 to 15 centimeters in diameter and 80 to 100 centimeters in length. Trunks 10 centimeters in diameter are split into four pieces; those 20 centimeters in diameter into six or eight pieces. Rajitas are smaller and are split from sections of trunks, branches, and roots ranging from 1 to 3 centimeters in diameter and from 60 to 70 centimeters in length. Three centimeter sticks are split into two or four pieces.

uan-lalaki; but it is much more inclined to be crooked, and its wood is not so good.

Bakauan-babae begins to flower in its third year, but is said not to bear fertile fruit till the fourth or fifth year.

In going hurriedly through the swamp in a boat, one gets the impression that more bakauan-babae is planted than bakauan-lalaki. This is because the bakauan-babae is planted at the edge of the stream.

#### CUTTING

Different practices in cutting are followed in different localities. In the Sexmoan and Guagua neighborhoods, the cutting is often done by contract. The owner gives the contractor one-half of the cut and furnishes the bancas for transportation. In such cases, the woody prop roots do not enter into the contract and are the property of the cutter, if he chooses to take them. It is said, however, that the owner can make a larger profit by employing his own men to do the cutting.

The firewood is regularly of three grades. The first grade is about 60 centimeters in length and 2 or 3 centimeters in thickness. It is split from the pieces of larger diameter and, locally, has a value of 2 pesos per thousand. The second grade is of the same length as the first, but is split from pieces of smaller diameter. It sells locally for 1 peso per thousand. The third grade is made of pieces which are shorter and of still smaller diameter. This grade sells locally for 2 pesos per 10,000 pieces.

Wood cutters, who cut the trees in the swamp, transport the poles to the wood yard, and split them there, are paid 0.625 peso per 1,000 pieces of the first grade, 0.625 peso per 2,000 of the second grade, and 0.625 peso per 10,000 pieces of the third grade. Consequently the cutter does not know just how much he will receive until the pieces have been split. The cutter takes the poles from the swamp in a banca and delivers them at his own or some other wood yard, where they are cut into firewood size. This splitting into firewood is often done by women and children. Only the straight pieces are cut up for firewood. The splitting is either done with a special, heavy-bladed, long-handled bolo, which is used with a chopping movement like an ax; or with a special, short-bladed, narrow ax.

The small air-roots of the bakauan are sometimes sold after being split once. They then bring about 50 centavos per thousand. They are not regularly classified, and often are not cut but are left to decay in the swamp.

The straight and slender tops of the bakauan, which are about 4 meters long, a centimeter in diameter at the top, and

2 or 3 centimeters in diameter at the base, are often sold to planters of ikmo (betel pepper) at 12 pesos per 100.

The very rough pieces, particularly those that occur where the prop roots are joined to the trunk, are used in making charcoal. The bark is also occasionally used for cooking, especially in the roasting of corn. This use does not seem to be general enough to have fixed a market price.

Ranger De Mesa has made a careful count of the number of the trees on several plots in bakauan plantations. The results are given in Tables XII to XIV. These tables show the number of trees of different lengths and diameters and the volume according to the length and diameter of the trees, also, the total number of trees and the total volume, and the percentage of trees and volume in the different length classes. In the lower portion of the table is shown the number, grades, and volume of the rajitas obtained by cutting and splitting the trees.

TABLE XII.—*Measurements of planted bakauan-lalaki near Orani, Bataan, at age of 7 years on 0.1 hectare (50 by 20 meters).*

[Data from report by Ranger De Mesa.]

Diameter class in cm.		Length class in meters.				Total.
		2.	3.	4.	5.	
2-----	Trees-----	454	300	189	104	1,047
	Volume in cu. m.-----	0.285	0.283	0.238	0.163	0.969
3-----	Trees-----		120	187	309	616
	Volume in cu. m.-----		0.254	0.529	1.092	1.875
4-----	Trees-----		50	165	376	591
	Volume in cu. m.-----		0.188	0.829	2.362	3.379
5-----	Trees-----			7	301	308
	Volume in cu. m.-----			0.055	2.955	3.010
Total-----	Trees-----	454	470	548	1,090	2,562
	Volume in cu. m.-----	0.285	0.725	1.651	6.572	9.233
Percentage of stand by-----	Trees-----	17.72	18.35	21.39	42.54	100.00
	Volume in cu. m.-----	3.09	7.85	17.88	71.18	100.00
STACKED RAJITAS.						
Grade of rajitas.					Pieces.	Volume.
						cu. m.
First-----					12,650	7.80
Second-----					22,195	6.40
Third-----					500	0.22
Stumps-----						1.50
Total-----					35,345	15.92



TABLE XIV.—Measurements of planted bakauan-lalaki near Sexmoan, Pampanga, at age of 7 years on 0.1 hectare (50 by 20 meters).

[Data from report by Ranger De Mesa.]

Diameter class in cm.		Length class in meters.			Total.
		3.	4.	5.	
2	Trees	214	280	72	566
	Volume in cu. m.	0.201	0.352	0.113	0.666
3	Trees	200	246	262	708
	Volume in cu. m.	0.424	0.696	0.926	2.046
4	Trees		240	560	800
	Volume in cu. m.		1.206	3.519	4.725
5	Trees		30	160	190
	Volume in cu. m.		0.236	1.571	1.807
Total	Trees	414	976	1,054	2,264
	Volume in cu. m.	0.625	2.49	6.129	9.244
Percentage of stand by	Trees	18.29	35.16	46.55	100.00
	Volume in cu. m.	6.76	26.94	66.30	100.00

## STACKED RAJITAS.

Grade of rajitas.	Pieces.	Volume.
		cu. m.
First	5,560	4.774
Second	17,600	7.825
Stumps		5.367
Total	23,160	17.966

The trees measured in Table XII were cut by six laborers, each working three hours a day for four days; those in Table XIII by four laborers working two to three hours a day for four days; and those in Table XIV by four laborers working half a day for three days.

The results in Tables XII and XIV were obtained from plantations 7 years old. The total volume in each on 0.1 hectare was 9.2 cubic meters. The trees recorded in Table XIII were 8 years old and showed a volume of 14.7 cubic meters on 0.1 hectare. The volume of stacked rajitas was in every case much greater than the volume obtained by measuring the trees. This difference was caused by the space occupied by air spaces.

## MARKETING OF BAKAUAN

Manila is the market place for most of the bakauan grown around Manila Bay, and transportation is naturally by water. The firewood is loaded into cascoes which are towed to Manila by launches. The charcoal is loaded on the regular steamer and pays a freight charge of 5 centavos per sack.

The first-grade rajitas sell in Manila and Malabon at from 3 to 4 pesos per 1,000 pieces; the second grade, from 3 to 4 pesos per 2,000 pieces; the third grade, from 3 to 4 pesos per 10,000 pieces; and the fourth grade, from 3 to 3.50 pesos per 4 cubic meters.

In Table XV are given the figures on cost of transporation from Bataan to Manila.

TABLE XV.—*Cost of transportation of firewood from Bataan to Manila.*

[Data from report by Ranger De Mesa.]

	Pesos.
Second-class casco with a load of 70,000 first-grade rajitas (7 to 14 days' trip).....	<sup>a</sup> 1.50
Crew of 5 men at 3 pesos each and 1 pilot at 6 pesos (1 trip).....	21.00
Subsistence of crew while on trip.....	8.00
First-class casco with a load of 100,000 first-grade rajitas (7 to 14 days' trip).....	<sup>a</sup> 2.00
Crew of 6 men at 4 pesos each and 1 pilot at 8 pesos (1 trip).....	32.00
Subsistence of crew while on trip.....	10.00

From the figures given in Tables XII and XIII, we have made rough estimates of the total cost, selling price, and profits derived from 1 hectare of a bakauan plantation. These figures are given in Tables XVI and XVII.

TABLE XVI.—*Cost and sale value in Manila of the erop of bakauan on 1 heetare, based on figures in Table XII for erop 7 years old.*

PLANTING COST.

	Pesos.
Clearing at 2 pesos per luang.....	72.00
Seedlings, 25,620 at 2 pesos per 1,000.....	51.00
Planting at 0.75 peso per 1,000.....	19.00
Compound interest on planting cost for seven years at 5 per cent .....	58.00
Total planting cost.....	200.00

HARVESTING AND SELLING COST.

Cutting and splitting 126,500 first-grade rajitas at 0.625 peso per 1,000 .....	79.00
Cutting and splitting 221,900 second-grade rajitas at 0.625 peso per 2,000 .....	69.00
Transportation 126,500 first-grade rajitas at 62 pesos per 100,000 .....	78.00
Transportation 221,900 second-grade rajitas at 40 pesos per 100,000 .....	89.00
Total harvesting and selling cost.....	315.00
Total cost.....	515.00

<sup>a</sup> Daily.

## SELLING PRICE.

126,500 first-grade rajitas at 3.50 pesos per 1,000.....	443.00
221,900 second-grade rajitas at 3.50 pesos per 2,000.....	388.00
Total selling price.....	831.00
Total cost.....	515.00
Total profit .....	316.00
Profit for one year.....	45.00
Profit per year based on cost of original planting (per cent).....	32

TABLE XVII.—*Cost and sale value in Manila of the crop of bakauan on 1 hectare, based on figures in Table XIII for crop 8 years old.*

## PLANTING COST.

	Pesos.
Clearing at 2 pesos per luang.....	72.00
Seedlings, 22,060 at 2 pesos per 1,000.....	44.00
Planting at 0.75 peso per 1,000.....	17.00
Compound interest on planting cost for 8 years at 5 per cent..	64.00
Total planting cost.....	197.00

## HARVESTING AND SELLING COST.

Cutting and splitting 134,000 first-grade rajitas at 0.625 peso per 1,000.....	84.00
Cutting and splitting 234,000 second-grade rajitas at 0.625 peso per 2,000.....	73.00
Cutting and splitting 18,000 third-grade rajitas at 0.625 peso per 10,000.....	1.00
Transportation of 134,000 first-grade rajitas at 62 pesos per 100,000 .....	83.00
Transportation of 252,000 second- and third-grade rajitas at 40 pesos per 100,000.....	101.00
Total harvesting and selling cost.....	342.00
Total cost.....	539.00

## SELLING PRICE.

134,000 first-grade rajitas at 3.50 pesos per 1,000.....	469.00
234,000 second-grade rajitas at 3.50 pesos per 2,000.....	409.00
18,000 third-grade rajitas at 3.50 pesos per 10,000.....	6.00
Total selling price.....	884.00
Total cost.....	539.00
Total profit.....	345.00
Profit per year.....	43.00
Profit per year based on original planting cost (per cent).....	32

The value of the land is not taken into consideration, because the area in cultivation is really a part of the shore line, or perhaps of the sea, and properly belongs to the Government. No account is taken of the cost of supervision, as it is very difficult to arrive at an estimate of this. However, a bakauan plantation takes

but little supervision and so this item is probably very small. From the figures given in Tables XVI and XVII, it would appear that raising bakauan should be profitable. It would appear further that it is much more profitable to market the crop in Manila than where it is grown. This is brought out in Table XVIII, in which the cost and selling price in Bataan are shown.

TABLE XVIII.—*Cost and selling prices in Bataan of the crop of bakauan on 1 hectare, based on figures in Table XIII for crop 8 years old.*

SELLING PRICE.		Pesos.
134,000 first-grade rajitas at 2 pesos per 1,000.....		268.00
234,000 second-grade rajitas at 1 peso per 1,000.....		234.00
18,000 third-grade rajitas at 2 pesos per 10,000.....		4.00
Stumps, 34.2 cubic meters at 2 pesos per cubic meter.....		17.00
Total selling price.....		523.00
Cost of clearing, seedlings, planting, and harvesting, with interest on planting.....		355.00
Total profit.....		168.00
Profit per year.....		21.00
Profit per year based on original planting cost (per cent).....		16

If sold in Manila, it will be seen that the profit per year, based on the planting cost, is 32 per cent plus 5 per cent compound interest, which is calculated in the tables as a part of the cost. When the wood is sold where grown, the calculated profit per year is 16 per cent plus the interest on the planting cost. About half of the original planting cost as calculated is due to clearing, which is frequently not necessary, perhaps never so for the second crop, if the planting is done at the right time. Where clearing is unnecessary, the percentage of profit would be much greater than that calculated.

When bakauan is planted on bare ground in shallow water, the roots by holding sand or mud on the area have a tendency to raise the level of the ground. When the land has been raised to about the level of high tide, the bakauan is frequently cut for firewood and the area made into fish ponds by the construction of dikes. The water in these ponds is usually brackish. In the Philippines, there is a considerable industry in the raising of the fish *Chanos chanos* Forskål, locally known as bañgós, in such ponds. As the raising of fish is a very profitable business, old bakauan plantations are frequently converted into fish ponds. In many places the growing of a crop of bakauan and the subsequent use of the land for fish ponds should be an exceptionally profitable investment. There are large areas in Manila Bay where this could be undertaken.

## MANGROVE-SWAMP FIREWOOD

The demand for fuel in the Philippines, excepting in the case of transportation companies and manufacturing plants, is met almost entirely by the use of firewood, as up to the present time comparatively little coal has been mined in the Archipelago and most of the supply comes from Japan. The coal industry in the Philippines is being developed, and 3,200 tons were mined in 1917.† The demand for fuel in a tropical country, such as the Philippines, is not nearly so great as in a temperate region; nevertheless, there is a large demand for domestic purposes, such as cooking, washing, etc., and for the smaller industries.

The most highly prized firewood is furnished by various species of mangrove-swamp trees. However, the available, accessible supply of these is not great enough to satisfy the demand and dry-land species have to be substituted. The amount of firewood of both classes on which taxes were paid in the Archipelago from 1914 to 1918, inclusive, is given in Table XIX.

TABLE XIX.—*Amount of firewood on which taxes were paid in the Philippine Islands from 1914 to 1918.*

Year.	Mangrove species.	Dry-land species.
	<i>cu. m.</i>	<i>cu. m.</i>
1914.....	28, 120	133, 274
1915.....	70, 427	142, 814
1916.....	97, 856	194, 480
1917.....	130, 472	277, 224
1918.....	134, 431	588, 109

From this table, it will be seen that during each successive year the amount of mangrove-swamp wood used has been greatly increased and that there has been a corresponding increase in the dry-land species; and further, that in every case, the amount of the dry-land species was each year more than twice as great as that of mangrove species. The figures in Table XIX show that the firewood business in the Philippine Islands is one of considerable proportions.

An extensive study of mangrove-swamp woods has been made by Cox.\* In Table XX are given the results of analyses and

† Cox, Alvin J., Annual Report of the Director, Bureau of Science, for 1918.

\* Cox, Alvin J., Philippine firewood, Philippine Journal of Science, Sec. A, Vol. 6 (1911), page 1.

\* Cox, Alvin J., Philippine fuels, Bureau of Science Press Bulletin No. 86.

calorific determinations made by him on air-dried wood without bark. In this table the dried wood is taken as the basis on which to compute the percentages of moisture and ash. From the table

TABLE XX.—Analyses and calorific determinations of air-dried wood without bark.

[The numbers and common names are those given by Cox in the original table. The scientific names have been inserted by Mr. E. E. Schneider, wood expert of the Bureau of Forestry, after a recent examination of specimens of the wood used by Cox.]

No.	Common and scientific names.	Moisture.	Ash.	Main calories. <sup>a</sup>	Available heating value.	Heating value of combustible matter, wood — (water + ash) in main calories. <sup>a</sup>	Available heating value of combustible matter, wood — (water + ash).
		<i>Per cent.</i>	<i>Per cent.</i>		<i>Calories.</i>		<i>Calories.</i>
3	Pototan ( <i>Bruguiera conjugata</i> )	13.01	1.46	4,180	3,833	4,798	4,480
		13.26	1.44	4,191	3,829	4,793	4,475
4	Bacauan ( <i>Rhizophora mucronata</i> ).	11.22	2.23	4,118	3,772	4,689	4,365
		11.37	2.29	4,107	3,746	4,682	4,358
5	Bacao ( <i>Bruguiera</i> sp.) -----	11.03	1.81	4,159	3,781	4,699	4,340
		10.94	1.74				
6	Bacauan-tubig ( <i>Bruguiera</i> sp.)	13.21	5.75	3,753	3,366	(b)	(b)
			5.57				
7	Catutan ( <i>Bruguiera</i> sp.) -----	13.79	1.28	4,142	3,705	4,787	4,368
		13.77	1.29				
8	Tabigue ( <i>Xylocarpus moluccensis</i> ).	13.93	2.80	4,005	3,634	4,694	4,345
9	Bacauan ( <i>Bruguiera</i> sp.) -----	13.77	2.05	4,066	3,764	4,723	4,456
		13.39	2.12				
10	Tambu-tambu ( <i>Xylocarpus moluccensis</i> ).	12.99	2.72	4,162	3,873	4,833	4,578
		12.99	2.71				
11	Pagatpat ( <i>Sonneratia caseolaris</i> ).	14.27	2.62	4,116	3,841	4,831	4,596
		14.27	2.65				
14	Bacauan ( <i>Rhizophora candelaria</i> ).	10.71	2.41	4,136	3,721	4,689	4,284
			2.26	4,154	3,760	4,720	4,328
15	Tangal ( <i>Ceriops tagal</i> ) -----	11.41	1.60	4,292	3,924	4,747	4,399
				4,293	3,906	4,747	4,378
16	Pototan ( <i>Bruguiera conjugata</i> )	12.26	1.55	4,286	3,895	4,840	4,466
				4,227	3,855	4,773	4,421
17	Lenggadi ( <i>Bruguiera parviflora</i> ).	11.97	1.65	4,072	3,716	4,629	4,296

<sup>a</sup> In the usual determination of the calorific value of a fuel in a calorimeter the products are cooled to the ordinary temperature and the result is therefore higher than can ever be realized in ideal practice, where the resulting gases always leave the flues at a temperature above 100°. Since the object of the determination of the calorific value of a fuel is to show its technical worth, I always have calculated the results on Philippine fuels on the assumption that the moisture present and the water formed during the combustion remain as steam at 100°, i. e., I have made a water correction by subtracting 6 calories for each per cent of water. Some mechanical engineers do not make this correction, and therefore obtain a result from 3 to 10 per cent too high, and in order that my results may be comparable in all cases I have decided to give also the uncorrected result under the caption "Main calories."

<sup>b</sup> On account of the very high ash content and the possibility of error in its determination (cf. p. 10), this sample has little comparative value and I have therefore not included the heating value of the combustible matter in the average. The calculated results for the combustible matters wood — (water + ash), in main calories and available calories are 4,482 and 4,123, respectively.



Fig. 1. Piled firewood cut mainly from tañgal and bakauan.



Fig. 2. Lancha load of rajitas.

it would appear that the moisture content is fairly constant for the different species. Cox found that in the Philippines, where the humidity is high and fairly constant, the variations in the moisture content are much less than where the climate is hot or cold, moist or dry, according to the season. He concluded that the moisture content of wood seldom falls below 12.5 or 13 per cent of the dry weight, and that these figures may be taken as good averages for thoroughly seasoned firewoods. The ash content varies considerably in different species. Cox says of the ash content that this is of comparatively little importance from the standpoint of firewood because the amount of ash is usually small. The calorific value based on the dry weight of the various species is fairly constant, as might be expected from the fact that the part of the wood left after deducting the water and ash would be almost the same in all cases.

TABLE XXI.—*Specific gravities of Philippine firewoods.*

[The numbers and common names are those given by Cox in the original table. The scientific names have been inserted by Mr. E. E. Schneider, wood expert of the Bureau of Forestry, after a recent examination of specimens of the wood used by Cox.]

No.	Common name.	Scientific name.	Moisture.	Ash.	Specific gravity.
			<i>Per cent.</i>	<i>Per cent.</i>	
3	Pototan -----	<i>Bruguiera conjugata</i> -----	13.58	1.46	0.7671
			13.51	1.44	0.7441
4	Bacauan -----	<i>Rhizophora mucronata</i> -----	<sup>b</sup> 12.10	2.29	<sup>c</sup> 0.9861
			<sup>d</sup> 11.46	2.23	<sup>c</sup> 0.9801
5	Bacao -----	<i>Bruguiera</i> sp. -----		1.81	
				1.74	
6	Bacauan-tubig -----	<i>Bruguiera</i> sp. -----	12.26	5.75	0.8799
			11.88	5.57	0.8732
7	Catutan -----	<i>Bruguiera</i> sp. -----	13.24	1.29	0.9136
			13.03	1.28	0.8868
8	Tabigue -----	<i>Xylocarpus moluccensis</i> -----	13.71	2.80	0.7412
			12.73		0.7333
9	Bacauan -----	<i>Bruguiera</i> sp. -----	13.07	2.12	0.996
			12.77	2.05	0.991
10	Tambu-tambu -----	<i>Xylocarpus moluccensis</i> -----	<sup>b</sup> 13.00	2.72	0.5954
			<sup>d</sup> 12.50	2.71	0.5668
11	Pagatpat -----	<i>Sonneratia caseolaris</i> -----	12.94	2.65	0.6688
			12.83	2.62	0.5867
14	Bacauan -----	<i>Rhizophora candelaria</i> -----	12.78	2.41	<sup>e</sup> 1.071
			12.45	2.26	<sup>e</sup> 1.002
15	Tangal -----	<i>Ceriops tagal</i> -----	13.25	1.60	0.890
			13.09		0.880
16	Pototan -----	<i>Bruguiera conjugata</i> -----	13.24	1.55	0.9426
			12.63		0.9336
17	Lenggadi -----	<i>Bruguiera parviflora</i> -----	13.37	1.65	0.8936
			13.32		0.8881
18	Pagatpat -----	<i>Sonneratia caseolaris</i> -----	(a)		0.8186
19	Pagatpat -----	<i>Sonneratia caseolaris</i> -----	(f)		0.8447

<sup>a</sup> Air-dry.

<sup>b</sup> Heartwood beginning to form.

<sup>c</sup> The heartwood sinks.

<sup>d</sup> Sapwood.

<sup>e</sup> Heavier than water.

<sup>f</sup> Unseasoned.



Fig. 1. Marketing firewood in Manila



Fig. 2. Firewood piled for sale in the Manila market.

In Table XXI are given the specific gravities of various mangrove-swamp woods as determined by Cox. From this table it will be seen that the woods of the Rhizophoraceae have a high specific gravity, averaging about 0.9. Usually the mature heartwood of all Rhizophoraceae sinks in water. As all well-seasoned woods have very nearly the same calorific value per unit of weight, the specific gravity is highly important in determining the relative fuel value of different woods. The specific gravity also indicates certain other factors. In general it may be said of woods otherwise equal, that those with low specific gravities kindle easily and flash quickly, the fire spreading rapidly; while those of high specific gravity behave in the opposite way.

From the determinations of specific gravity, Cox has made comparisons of the fuel value of certain North American woods and of the mangrove-swamp species of the Philippines. Good woods include those having specific gravities between 0.60 and 0.75. Among the North American species classed as good are hard pines, maple, ash, beech, birch, elm, black walnut, and a number of different oaks. The only mangrove-swamp wood placed by Cox in this class is tinductinducan (*Aegiceras corniculatum*). Very good woods are those with specific gravities between 0.75 and 0.90. North American woods included in this class are some of the oaks and various species of hickory. In this class Cox includes tabigue (*Xylocarpus moluccensis*), pagatpat (*Sonneratia caseolaris*), and langarai (*Bruguiera parviflora*). Cox does not mention any of the North American species as having excellent woods, that is with a specific gravity greater than 0.9. In this class are included pototan (*Bruguiera conjugata*), bacauan (*Rhizophora mucronata*), catutan (*Bruguiera* sp.), tangal (*Ceriops* spp.). This comparison emphasizes the very high value of the mangrove-swamp species for firewood.

In Table XXII are given the analyses and calorific determinations made by Cox on air-dried bark.

TABLE XXII.—*Analyses and calorific determinations of air-dried bark.*

[The numbers and common names are those given by Cox in the original table. The scientific names have been inserted by Mr. E. E. Schneider, wood expert of the Bureau of Forestry, after a recent examination of specimens of the wood used by Cox.]

No.	Common and scientific names.	Mois- ture.	Ash.	Main calo- ries. <sup>b</sup>	Available heating value.	Heating value of combust- ible matter, wood— (water +ash) in main calories.	Available heating value of combust- ible matter, wood— (water +ash).
		<i>Per cent.</i>	<i>Per cent.</i>		<i>Calories.</i>		<i>Calories.</i>
3	Pototan ( <i>Bruguiera conjugata</i> )	13.90	6.72	3,983	3,668	4,863	4,568
4	Bacauan tubig ( <i>Rhizophora mucronata</i> ) -----	10.23	10.37	3,971	3,664	4,884	4,575
6	Bacauan ( <i>Bruguiera</i> sp.) -----	15.67	8.19	{ 4,054	3,708	5,124	4,791
7	Catutan ( <i>Bruguiera</i> sp.) -----	16.27	4.60	{ 4,034	3,692	5,099	4,771
8	Tabigue ( <i>Xylocarpus moluc- censis</i> ) -----	16.21	7.93	4,037	3,710	4,920	4,624
9	Bacauan ( <i>Bruguiera</i> sp.) -----	16.21	7.93	3,848	3,488	4,857	4,510
10	Tambu-tambu ( <i>Xylocarpus moluccensis</i> ) -----	15.70	8.17	3,891	3,565	4,903	4,594
		15.74	8.39	3,841	3,536	4,853	4,571

<sup>b</sup> See footnote "a" of Table XXI.

Concerning the relative value of mangrove-swamp woods and imported coal we may quote the following from Cox:

The available heating value of any well-seasoned wood is about 3,680 calories, and the specific gravity of well-seasoned mangrove wood (*Rhizophoraceae*) is about 0.9. From the latter value the weight of a solid cubic meter of meter lengths is about 900 kilograms and of a solid cord (8 by 4 by 4 English feet) is about 3,260 kilograms. In some parts of the Philippine Archipelago 2 cubic meters (2 by 1 by 1 meters) are called a talacsan. Since there are generally 35 per cent of voids, or interstices, in wood of a meter or more in length, one actually obtains about 585 kilograms and 2,120 kilograms of this wood in a cubic meter and in a cord, respectively. The available calorific (fuel or heating) value of green wood is less than of dry wood by an amount not only proportional to the decreased wood fiber per unit weight, but also by the amount of heat necessary to evaporate and be carried away by the excess moisture, and that of green mangrove wood containing 38 per cent water is about 2,420 calories. \* \* \* A commercial concern found that a cord of green mangrove wood contained about 18 per cent more water than well-seasoned wood weighing 2,550 kilograms, which checks with these numbers. The available heating value of an average imported coal (Tagawa) is approximately 6,500 calories. From the above numbers it may be computed that, in general, a ton of this coal is theoretically equivalent to 3 cubic meters or 0.83 cord of air-dry Philippine mangrove wood and to 3.24 cubic meters or 0.89 cord of green mangrove wood containing 38 per cent moisture. In the latter case 42 per cent extra weight will have to be handled. However, various consumers report the use in actual practice of one and one-third or more cords of wood in lieu of 1 ton of coal.

In view of data given above it is not surprising that the mangrove-swamp species are highly prized for firewood, that the swamps near the centers of population have been largely depleted of the more valuable species, and that bakauan is raised in plantations.

#### TANBARKS

The mangrove barks constitute the greatest single source of tanning material in the Philippines. The species of mangrove trees which are used commercially for tanning purposes grow in the Philippines in large numbers. The export of mangrove tanbarks and of the bark extract, known as cutch, is an important industry in some tropical countries. In the Philippines this industry has never been developed, and the barks are used locally to only a limited extent; although there are extensive swamps in the Archipelago. The Philippines possesses an advantage over such countries as Borneo in that owing to a large population the wood can be used as firewood; so that it would seem advisable to combine the bark collection with the cutting of firewood.

Extensive analyses of Philippine mangrove-swamp barks have been made by Bacon and Gana \* and by Williams.† In Table XXIII are given the results of analyses made by Bacon and Gana of barks from Mindanao; and in Table XXIV analyses of barks from Mindoro made by the same workers. Table XXV gives the results of analyses of barks submitted by the Bureau of Forestry to the Bureau of Plant Industry at Washington. These figures are published by Williams. In Table XXVI are given the results of analyses made by Williams. Table XXVII shows the results of analyses made on barks from Sarawak, Borneo.

---

\* Bacon, R. B., and Gana, V. Q., The economic possibilities of the mangrove swamps of the Philippines, *Philippine Journal of Science*, Sec. A, Vol. 4 (1909), pages 205 to 210.

† Williams, R. R., The economic possibilities of the mangrove swamps of the Philippines, *Philippine Journal of Science*, Sec. A, Vol. 6 (1911), pages 45 to 61.

TABLE XXIII.—Analyses of mangrove-swamp barks from Port Banga, Zamboanga.

[Data from Bacon and Gana.]

Common name.	Scientific name.	Moisture.	In parts per 100 of water-free bark.			
			Insolubility.	Total extract.	Non-tannin.	Tannin.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Busain -----	<i>Bruguiera conjugata</i> (Linn.) Merr.	16.1	63.0	36.96	9.8	27.2
Do -----	do -----	13.5	62.0	38.0	13.5	24.5
Lañgarai -----	<i>Bruguiera parviflora</i> W. and A.	13.9	84.1	15.9	7.1	8.8
Do -----	do -----	13.8	80.4	19.6	8.0	11.6
Tañgál -----	<i>Ceriops tagal</i> (Perr.) C. B. Robinson.	12.4	65.2	34.8	11.6	23.2
Do -----	do -----	11.9	58.6	41.4	19.1	22.3
Bakáuan-lalaki -----	<i>Rhizophora candelaria</i> DC.	13.4	68.7	31.3	13.3	18.0
Bakáuan-babaye -----	<i>Rhizophora mucronata</i> Lam	14.4	61.7	38.3	12.4	25.9
Tabigue -----	<i>Xylocarpus granatum</i> Koen	14.9	69.7	30.3	8.6	21.7
Do -----	do -----	14.2	67.6	32.4	7.7	24.7

TABLE XXIV.—Analyses of mangrove-swamp barks from Mindoro.

[Data from Bacon and Gana.]

Common name.	Scientific name.	Moisture.	In parts per 100 of water-free bark.			
			Insolubility.	Total extract.	Non-tannin.	Tannin.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Busain -----	<i>Bruguiera conjugata</i> (Linn.) Merr.	13.9	60.2	39.8	11.6	28.2
Do -----	do -----	13.9	63.4	36.6	12.6	24.0
Lañgarai -----	<i>Bruguiera parviflora</i> W. and A.	14.0	77.4	22.4	9.6	12.8
Do -----	do -----	14.8	75.5	24.5	9.6	14.9
Do -----	do -----	12.9	82.1	17.9	8.3	9.6
Tañgál -----	<i>Ceriops tagal</i> (Perr.) C. B. Robinson.	11.8	69.1	30.9	9.7	21.2
Do -----	do -----	12.3	72.5	27.5	10.5	17.0
Do -----	do -----	12.7	71.5	28.5	8.0	20.5
Bakáuan-lalaki -----	<i>Rhizophora candelaria</i> DC.	13.2	67.4	32.6	12.0	20.6
Do -----	do -----	13.5	64.8	35.2	10.8	24.4
Do -----	do -----	14.4	66.6	33.4	10.7	22.7
Do -----	do -----	14.1	67.1	32.9	10.0	22.9
Bakáuan-babaye -----	<i>Rhizophora mucronata</i> Lam.	13.2	64.3	35.7	14.1	21.6
Do -----	do -----	13.4	67.1	32.9	15.1	17.8

TABLE XXV.—Analyses of Philippine mangrove-swamp barks submitted by the Bureau of Forestry to the Bureau of Plant Industry at Washington.

[Data from Williams.]

Common name.	Scientific name.	Total solids.	Soluble solids.	"Reds."	Non-tannin.	Tannin.
Lañgárai -----	<i>Bruguiera parviflora</i> W. and A.	24.43	19.82	4.61	7.27	12.55
Potótan -----	<i>Bruguiera sexangula</i> (Lour.) Poir.	37.36	36.81	0.55	10.15	26.66
Tañgál -----	<i>Ceriops tagal</i> (Perr.) C. B. Rob.	58.58	49.02	9.56	13.19	35.83
Bakáuan -----	<i>Rhizophora candelaria</i> DC.	53.91	51.03	2.88	11.64	39.39

TABLE XXVI.—Analyses of Philippine mangrove-swamp barks.

[Data from Williams.]

Species.	Number of determinations.	Average of determinations.
<i>Bruguiera conjugata</i> (Linn.) Merr. -----	13	32.4
<i>Bruguiera sexangula</i> (Lour.) Poir. -----		
<i>Bruguiera parviflora</i> W. and A. -----	14	9.1
<i>Ceriops tagal</i> (Perr.) C. B. Rob. -----	5	31.3
<i>Rhizophora candelaria</i> DC. -----	9	27.8
<i>Rhizophora mucronata</i> Lam. -----	23	27.6
<i>Sonneratia caseolaris</i> Linn. -----	4	11.8
<i>Xylocarpus moluccensis</i> (Lam.) M. Roem. -----	2	23.0
<i>Xylocarpus granatum</i> Koen. -----	2	23.2

TABLE XXVII.—Analyses of mangrove-swamp barks from Sarawak, Borneo.<sup>a</sup>

[Data from Bacon and Gana.]

Common name.	Scientific name.	Moisture.	Insolubility.	Total extract.	Non-tannin.	Tannin.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Busain -----	<i>Bruguiera conjugata</i> (Linn.) Merr.	15.5	64.3	35.7	9.0	26.7
Potótan -----	<i>Bruguiera sexangula</i> (Lour.) Poir.	16.1	64.0	36.0	8.0	27.2
Tañgál -----	<i>Ceriops tagal</i> (Perr.) C. B. Robinson.	13.8	63.8	36.2	6.9	29.3
Bakáuan-lalaki ..	<i>Rhizophora candelaria</i> DC.	14.7	58.3	41.7	9.6	32.0
Bakáuan-babaye ..	<i>Rhizophora mucronata</i> Lam.	14.4	70.1	29.9	9.4	20.5

<sup>a</sup> Analysis was made of some samples of mangrove barks brought from Sarawak, Borneo, by Dr. Foxworthy, of the botanical division of this Bureau. These barks are used by cutch factories and among the species in Borneo probably yield the highest amount of tannin.

TABLE XXVIII.—Yield of bark from mangrove trees of different sizes.

[Data from Foxworthy and Matthews.]

Dia- meter.	Species.			
	Rhi- zophora cande- laria.	Rhi- zophora mucro- nata.	Bru- guiera conju- gata and Bru- guiera sexan- gula.	Ceriops tagal and Ceriops roxburg- hiana.
Inches.	Kilos.	Kilos.	Kilos.	Kilos.
3	4	4	3	2
4	6	6	5	3
5	12	11	7	5
6	21	19	9	9
7	30	30	16	13
8	41	41	18	21
9	56	52	24	30
10	72	66	30	40
11	90	83	39	54
12	110	98	47	-----
13	133	121	57	-----
14	157	145	66	-----
15	193	178	78	-----
16	236	223	91	-----
17	287	266	103	-----
18	-----	-----	120	-----
19	-----	-----	139	-----

In Table XXVIII is shown the yield of bark from trees of different sizes of *Rhizophora candelaria*, *Rhizophora mucronata*, *Bruguiera conjugata* and *Bruguiera sexangula*, and *Ceriops tagal* and *Ceriops roxburghiana*. The figures in this table were calculated from a table by Foxworthy and Matthews.\*

Very various results have been obtained by analyzing the barks of the same species, and it has been often stated that the bark from some countries is richer in tannin than that from others. Williams† says that the percentage of tannin increases with the size of the tree. He believed, however, that this increase was due rather to the age than to the size. In drying, barks also lose a certain portion of their tannin, especially if not properly dried. Owing to these facts and to the varied results obtained by analyses it is questionable as to

\* Foxworthy, F. W. and Matthews, D. M., Mangrove and nipah swamps of British North Borneo, Department of Forestry Bulletin No. 3 (1917), page 16.

† Williams, R. R., The economic possibilities of the mangrove swamps of the Philippines, Philippine Journal of Science, Sec. A, Vol. 6 (1911), pages 45 to 61.

whether or not bark of the same age has a different tannin content in different regions. The barks from East Africa are, however, reported to be richer in tannin than those from the Indo-Malayan region. The Philippine barks certainly appear to be as rich as those in Borneo which have been used in cutch factories. Owing to the relatively low price that the crude barks command and the expenses of shipping, it would probably be advisable to export cutch rather than the crude barks.

Cutch is not only used as a tanning material but also as a dye. A short history of the uses of cutch has been given by Foxworthy.\* The name cutch was originally applied to a product of the heartwood of *Acacia catechu* Willd., which has been known from India and Burma for many years.

TABLE XXIX.—Amount of tanbarks and dye barks on which forest charges were paid in the Philippine Islands from 1914 to 1918, inclusive.

Year.	Tanbarks.	Dye barks.
	Kilos.	Kilos.
1914.....	2, 793, 295	58, 714
1915.....	1, 913, 558	94, 492
1916.....	1, 543, 686	93, 057
1917.....	3, 165, 687	84, 364
1918.....	1, 973, 786	148, 764

The supply was however not entirely uniform or reliable. When the product from the mangrove trees came into the market it superseded the Indian cutch to such an extent that this term is now used mainly with reference to the mangrove extracts. With the advent of the common use of aniline dye it was found that the Bismark browns furnished a cheaper and a more easily handled dye than cutch and, consequently, the use of the latter as a dye gradually ceased.

The bark of *Ceriops* spp. is used locally for coloring rice and tuba and for dyeing. The bark of *Xylocarpus granatum* is also used locally to a considerable extent for dyeing purposes. The dyeing property of the barks of *Ceriops tagal* and *Xylocarpus granatum* is not great, and they are of more use as mordants. They are, however, used in large quantity for dyeing fishnets, ropes, sails, and clothing used in salt water. Table XXIX shows the amount of tanbarks and dye barks upon which forest charges were paid from 1914 to 1918. The barks consisted very largely of mangrove-swamp species, the dye barks chiefly of *Ceriops* spp. and *Xylocarpus granatum*.

\* Foxworthy, F. W., Cutch, Philippine Journal of Science, Sec. A, Vol. 3 (1908), page 534.

Many mangrove swamps in the Philippines have been so thoroughly depleted of the larger-sized and more valuable trees that even though they cover extensive areas they would not be capable of supporting a cutch factory. However, there are areas in Mindanao, Mindoro, and Palawan which, although they may not be as large as some in Borneo, still offer promising sites for cutch factories. In Sibuguey Bay, Mindanao, there is a well developed swamp covering an area of 25,000 hectares. Concerning this area Williams † says:

I have found that this area will yield about 20 metric tons per hectare of fresh bark of mature trees of selected species averaging about 28 to 30 per cent of tannin on the dry weight. Only four species are included in this estimate, all others being negligible from a commercial standpoint. The natural resources are sufficient for a profitable industry, the swamps being fully as valuable, hectare for hectare, as many now being worked in the East Indies.

A survey of the data shows that only four species can be depended upon to furnish a supply of bark. They are *Rhizophora mucronata*, *Rhizophora conjugata* [*candelaria*], *Bruguiera gymnorhiza* [*conjugata*], and *Bruguiera eriopetala* [*sexangula*], the two former commonly known as "bacauan" (bakáuan-lalaki and bakáuan-babaye respectively), the two latter as "pototan" or "pitutan." Tañgal, which is the "teñgah" bark of Borneo upon which the manufacturers there depend to a considerable extent, is scarce on Sibuguey Bay. Both *Xylocarpus granatum* and *Xylocarpus obovatus* [*granatum*] yield too small quantities of bark per tree to be remunerative. *Bruguiera parviflora* has a very low tannin content, as has *Sonneratia pagatpat* [*caseolaris*].

However, a use may be found for the last mentioned for blending with the more valuable barks, since it produces a leather of good, brown color, very different from any tanned by barks of the Rhizophoraceae.

In calculating the yield of bark in the area examined, only bacauan and pototan tree 20 centimeters or more in diameter have been counted. For this purpose seven rectangular areas of about one-fourth hectare each were selected as representative after a fairly through exploration of the surrounding swamp. These areas are distributed at approximately regular intervals between the mouths of the Vitali and Buluan Rivers. The yield of bark per tree was determined by felling three representative trees each of bacauan and pototan and stripping and weighing the bark. Bacauan averaged 140 kilograms per tree, pototan 190 kilograms. On this basis the area will yield 20.6 metric tons of bacauan bark per hectare, and 5.8 tons of pototan. We may safely state the yield at 20 tons per hectare of bark.

In Mindoro there is a tract of 10,000 hectares and in Palawan a fairly compact area of good swamp. The swamps in the other islands of the Archipelago are so scattered as to make the success of a cutch factory doubtful.

---

† Williams, R. R., The economic possibilities of the mangrove swamps of the Philippines, Philippine Journal of Science, Sec. A, Vol. 6 (1911), page 47.

Concerning the manufacture of cutch from Philippine materials Bacon and Gana \* write as follows:

There are three large cutch factories in Borneo using tan barks from the same species of mangrove as those found in the Philippines. These factories regard the process of manufacturing cutch as a trade secret, but we can not believe that these so-called trade secrets are of a very formidable nature, as we have succeeded in preparing very good grades of cutch without any complicated processes in this laboratory. Our cutch is a dry, brown solid with a brilliant, almost metallic, fracture. It is easily and completely soluble in water and the analysis shows the following constituents:

Constituent.	In parts per 100 of water-free material.	
	I.	II.
	Per cent.	Per cent.
Moisture -----	2.6	5.7
Insoluble -----	1.9	1.3
Soluble -----	98.1	98.7
Non-tannin -----	28.8	26.1
Tannin -----	69.3	72.6

The following was the method used to prepare the cutch:

The finely ground bark was leached with cold water, and this solution evaporated to dryness *in vacuo*. Hot water extracts too much of the coloring matter, and no more tannin than cold water. The evaporation, at least the latter stages, must always be made *in vacuo* to avoid burning the cutch. It is sufficiently obvious that the extraction on a large scale would be carried out in such a manner that strong solutions would be employed to leach fresh bark while weak ones would be used to extract the last percentages of the tannin from the partly exhausted bark. All the parts of the factory, except the vacuum dryers, could be built on the ground, and it is evident that the fuel for the boilers and for the dryers would cost very little, so that it would appear that if the cutch manufacture were taken up in connection with the lumbering or firewood industry that it would be exceedingly profitable.

The chief objection to the use of cutch as a tanning material seems to be that it produces a reddish brown leather which is somewhat harsh and thick-grained, due to the high astringency of the tannin; but when mixed with other materials it gives a very satisfactory tannage.†

\* Bacon, R. F. and Gana, V. Q., The economic possibilities of the mangrove swamps of the Philippines, Philippine Journal of Science, Sec. A, Vol. 4 (1909), pages 206 to 207.

† Williams, R. R., The economic possibilities of the mangrove swamps of the Philippines, Philippine Journal of Science, Sec. A, Vol. 6 (1911), page 56.

## ECONOMIC USES OF THE NIPA PALM

## THATCHING

Economically the nipa palm takes a very high rank among the plants of the Philippines. Throughout the Islands, except in inaccessible regions, the leaves are used extensively for thatching. Most of the people dwell in light-construction houses, and nipa is by far the commonest material used for thatching such dwellings. Nipa shingles are also sometimes used for the walls of houses. As nipa roofs take fire readily and a fire in a nipa district spreads with great rapidity and can be controlled with great difficulty, if at all, the use of this material for thatching houses has now been prohibited in a considerable portion of the city of Manila and other large towns.

The nipa shingles are made by removing the leaflets from the petiole, and doubling back one-third of the length of the leaflet over a slender piece of bamboo, the leaflets being so placed that they overlap. They are then sewed in place to form an oblong shingle, usually about 70 centimeters in length. In Pampanga a woman will, as a rule, prepare from four hundred to five hundred of these shingles in a day, and some will make as many as eight hundred a day. The shingles are usually tied in bundles of ten to facilitate handling them.

## OTHER USES OF LEAVES

The leaflets are not only used for building purposes, but also for making raincoats and sun hats (salacots), coarse baskets, mats, and bags. The midribs of the leaves are used for tying bundles of rice, for sewing nipa shingles, and for making coarse brooms. The petioles are employed as fuel, while splints prepared from the cortex are sometimes used for making baskets.

## SEEDS

The immature seeds are used for food, the taste and the consistency being similar to those of the flesh of immature coconuts. They are sometimes made into a kind of sweetmeat. The mature seeds are too hard to be eaten.

## ALCOHOL

Nipa is very important as a source of alcohol and vinegar, and is a promising source of sugar. This subject has been extensively investigated by Gibbs,\* from whose article most of the information on this subject is taken. The production of proof

---

\* Gibbs, H. D., The alcohol industry of the Philippine Islands. Part I, Philippine Journal of Science, Sec. A, Vol. 6 (1911), pages 99 to 145.

alcohol in the Philippines exceeds thirteen million liters annually, and about 55 per cent of this is the product of the nipa palm. The alcohol is obtained by distilling the fermented juice which flows from a cut inflorescence stalk after the fruiting head has been removed. As the inflorescence of the nipa is near the ground, the flower stalk is conveniently situated for the gathering of the sap, called tuba. Some time after the fruit is formed, the stalk is cut across near its top, usually just below the fruit; and each day a thin slice is removed to keep the wound fresh and to facilitate exudation. If the plant bears two flower stalks the usual practice is to take sap from only one, the other being removed.

Sap is collected in bamboo joints which are hung on the stem. These containers are about 45 centimeters high and 8 centimeters in diameter and have a capacity of about 2 liters (Plate XLV). The stalk usually flows for about three months, but it is not uncommon for it to be cut away, or at least cut so close to the ground that the daily paring is impracticable, long before the flow has ceased. In some districts the stem is cut before the fruit is formed and under such conditions the daily yield of sap is said to be increased, but the period of flow reduced from three to one and one-half months, the total yield being practically the same in both cases. The season of gathering the juice is usually of about six months' duration.

Gibbs came to the conclusion that with the present method of caring for a nipa area an average plant would produce 43 liters of sap during the season, while a conservative estimate † places the number of palms in a cultivated swamp at between 2,000 to 2,500 per hectare, of which 750 may be depended upon to produce fruiting stalks and consequently be available for sap collection.

Gibbs gave the following composition for sap of the best quality:

Density 15°/15° .....	1.0720
Total solids .....	18.00
Ash .....	0.48
Acidity .....	Trace.
Sucrose .....	17.00
Reducing sugars .....	Trace.

† Gibbs, H. D., The alcohol industry of the Philippine Islands. Part I, Philippine Journal of Science, Sec. A, Vol. 6 (1911), pages 99 to 145.

† Pratt, D. S., Thurlow, L. W., Williams, R. R., and Gibbs, H. D., The nipa palm as a commercial source of sugar, Philippine Journal of Science, Sec. A, Vol. 8 (1913), pages 377 to 398.



Fig. 1. Nipa swamps as far as the eye can reach.



Fig. 2. Uncultivated nipa swamp.

He found that the inversion of the sucrose began after the sap is dropped from the stem and concluded that it was due to the formation of an enzyme.

Tuba is carried by small boats (bancas) from the place of collection to the distilleries. According to Gibbs the inversion is complete and the alcoholic fermentation well under way and sometimes completed before the sap arrives at the distillery. Sometimes the acetic acid fermentation has progressed to a considerable extent. The yield of alcohol obtained from the sap varied from 4.1 to 7.5 per cent, the average for thirty-three distilleries was 5.6 per cent. Due to faulty methods the yield of alcohol is not what it should be. The average price paid for the sap at the distillery is, according to Gibbs, 0.006 peso per liter. Gibbs says that the alcohol produced from the nipa sap should be about 6 per cent of the tuba, and under favorable conditions he believes above 7 per cent. With a yield of 6.5 per cent alcohol, the purchase price of the raw material would be equivalent to a cost of 0.0415 peso to 0.0830 peso per liter for 90 per cent alcohol. His estimates would indicate that nipa sap is the cheapest known source of alcohol. For manufacturing alcohol, nipa possesses several advantages over grains in that it does not need purification, pulping, etc. The storage space and fermentation vats may also be smaller, since fermentation is complete in from six to ten hours and the material ready to be distilled. Gibbs estimates that the owner of a nipa area by selling sap clears about 129 pesos per hectare per annum.

In some distilleries, especially in those near sugar cane lands, molasses is added to the fermenting sap. The molasses, which usually contains about 60 per cent of fermentable carbohydrates, is sometimes used in amounts equal to that of the tuba. According to Gibbs the advantages are threefold: The invertase and alcoholic ferment in the tuba act with great rapidity upon the molasses, providing an easy method for the utilization of the latter; the production of alcohol is greatly increased; and when there is a shortage in the supply of sap, the uninterrupted running of the stills is assured. The use of molasses during a portion of the season enables some distilleries to operate during the entire year.

#### TUBA

The fermented juice (tuba) of the nipa palm is used extensively by the Filipinos as a beverage. It resembles apple cider in appearance and flavor.



PLATE XLVI. CULTIVATED NIPA SWAMP.

## VINEGAR

Considerable quantities of vinegar are manufactured from nipa tuba by allowing acetic fermentation to follow alcoholic fermentation. The methods at present used are very crude and the product inferior, containing only from 2 to 3 per cent acetic acid.

## CULTIVATION OF NIPA

A considerable amount of capital is invested in the nipa-alcohol industry, large distilleries exist in various nipa swamps, and the swamps themselves have been improved. Artificial channels have been dredged, to make the nipa areas more accessible for the purpose of gathering and transporting the sap, and in some places the nipa areas have been extended by planting, yet at the present time only a small part of the available "nipales" is commercially utilized.

The best publication on the cultivation of nipa is a small pamphlet published in Manila in 1906, by Enrique Zobel, entitled "Estudio de la planta nipa." The following information is taken largely from this publication:

Nipa is planted in the months from May to July, the seeds being placed in holes 1.7 to 2 meters apart. The period of development does not exceed four years in which time flowers are produced and the plant can be utilized for the production of alcohol. During the first year the plant grows from 1.5 to 2 meters. The seeds carried by water and deposited on land under shade seem to develop better and to produce healthier plants than those artificially planted in the open. Nipa is not only reproduced by seeds but also by the branching of the rhizome. In order to keep a nipal (nipa swamp) in good condition, the plants must be thinned until they are from 1.5 to 1.7 meters apart. In doing this it is necessary to cut up the roots of the plants removed to prevent their regeneration. At the end of two years a nipa plant has seven to eight leaves, and this number is maintained throughout its life. If a nipa swamp is cultivated for the sap, the fresh leaves should not be cut, while it is very advantageous to remove the drooping or drying leaves which can be used for thatching houses, etc. When roofing material and not tuba is desired, three or four fresh leaves may be cut, but this interferes with the development of the plant and greatly decreases the flow of tuba.

If nipa is cultivated for alcohol, care should be taken not to injure the plant at the time of flowering, as an injury at this



Fig. 2. Nipa palms in fruit.



Fig. 1. Collecting the nipa sap.

PLATE XLVII.

time is likely to cause the flower to die. The first thing done before the gathering of sap is the cleaning of the nipa. The ground is cleared of weeds and vines and any other obstacles that interfere with the workman passing between the plants to collect tuba. At this time the mature leaves are cut off, tied into bundles, and transported to the houses where the women make the nipa shingles.

#### SUGAR

It is possible that the nipa palm may prove to be a profitable commercial source of sugar. This subject has been quite extensively investigated by chemists of the Bureau of Science,\* with the following general results: With a normal average of sap flow of from 30 to 50 liters per plant over a period of three months, with a sap-collecting period of six months, and with an average of 750 bearing trees per hectare, it was found that 1 hectare would produce an average quantity of 30,000 liters of sap. The cost of collection and delivery at a sugar mill was found to be about 3 pesos per 1,000 liters; and the sugar yield about 115 kilograms of commercial white sugar, polarizing at 99 or above, per 1,000 liters of sap. The palm juice has the advantage over cane juice of being free from acids, waxes, etc., colorless, with no débris, and, when fresh, with no invert sugar. The chief difficulty in utilizing nipa as a source of sugar lies in the fact that normally fermentation commences with the flow of sap from the cut peduncle, that enzymes are present in the sap which will in time cause the complete inversion of the sucrose, and that it is difficult to prevent this inversion. With the use of a modified type of container freshly lined with lime cream and sulphite, for gathering the sap, fermentation and inversion can be prevented or inhibited for at least twelve hours, thus allowing sufficient time to collect and deliver the sap without undue loss of sucrose.

#### FOREST CHARGES

The mangrove-swamp areas are property of the Philippine Government and are not sold but developed under a license system. Usually small operators work under an ordinary yearly license for definite small areas. Exclusive licenses (or con-

---

\* Gibbs, H. D., The alcohol industry of the Philippine Islands. Part I, Philippine Journal of Science, Sec. A, Vol. 6 (1911), pages 99 to 145.

\* Pratt, D. S., Thurlow, L. W., Williams, R. R., and Gibbs, H. D., The nipa palm as a commercial source of sugar, Philippine Journal of Science, Sec. A, Vol. 8 (1913), pages 377 to 398.

cessions, as they are popularly called) are generally in the form of a twenty-year exclusive license to cut and extract timber, firewood, dye and tanbarks and other minor forest products from a specific tract. The land is in no way affected as merely the timber and minor forest products are included. Areas of 10 hectares are leased for factory or mill sites free of charge, as are also all rights of way for the operation of a concession. The charges are only nominal and are collectable after the products have been gathered.

A charge of 20 centavos per cubic meter is paid on wood cut for firewood; if cut for lumber, the charge is according to the group, Philippine wood being divided into four groups. *Lumnitzera* spp. belongs to the second group, which is assessed at 1.50 pesos per cubic meter. *Sonneratia pagatpat* and *Xylocarpus moluccensis* belong to the third group, on which there is a charge of 1 peso per cubic meter. All of the other timbers from the mangrove swamps belong to the fourth group on which a charge of 50 centavos per cubic meter is paid. Tanbarks are assessed at 30 centavos per hundred kilograms, and dye barks at 50 centavos per hundred kilograms.



# INDEX

	Page.
Acacia catechu .....	116
Acanthaceae .....	22, 26, 76
Acanthus .....	24, 26, 76
Acanthus ebracteatus .....	18, 22, 76, 78
Acanthus ilicifolius ....	18, 22, 23, 76, 78, 79, 95
Acrostichum .....	24, 27
Acrostichum aureum .....	18, 22, 23, 26, 27
Aegiceras .....	25, 66
Aegiceras corniculatum .....	16, 22, 23, 66, 68, 69, 70, 71, 110
Aegiceras floridum .....	22, 66, 70, 72
Agnáia .....	62
Akat .....	23
Álay .....	48
Alcohol from nipa palm.....	119
Alipata .....	34
Analyses of mangrove firewood.....	106
Analyses of mangrove tanbarks.....	113
Anibong .....	22, 23, 30
Anilái .....	62
Anípa .....	26
Api-api .....	22, 23, 74, 76, 88, 90, 91, 92, 93, 94
Apocynaceae .....	22, 26, 70
Area of mangrove swamps.....	11
Arinaya .....	78
Asplenium nidus .....	18
Avicennia .....	24, 26, 74
Avicennia alba .....	22, 74, 75
Avicennia officinalis .....	16, 17, 22, 74, 75, 76, 77, 90
Avicennia spp .....	16, 23
Bacao .....	106, 108
Bacauan .....	106, 108, 110
Bacauan-tubig .....	106, 108, 111
Bakad .....	62
Bakáo .....	46
Bakáu .....	23, 46, 62
Bakáuan .....	46, 48, 56, 62, 80, 82, 83, 84, 86, 87, 88, 90, 91, 92, 93, 94, 95, 98, 100, 101, 107, 104
Bakáuan-babae .....	22, 23, 62, 96, 100, 113, 114, 117
Bakáuan-lalaki ....	22, 23, 48, 52, 62, 96, 99, 100, 101, 113, 114, 117
Bakhao .....	62
Bakhau .....	62
Bako .....	23
Bakting .....	62
Baku .....	23
Balasiái .....	78
Balinsaráyan .....	48
Balúno .....	34
Bangkáu .....	62
Bankita .....	23
Banig-banig .....	78

	Page.
Baraybay .....	22, 70
Barringtonia racemosa .....	20
Barit .....	36
Basiad Bay mangrove swamps.....	83
Batag-batág .....	66
Batano .....	34
Bat-ano .....	70
Bating .....	62
Baut .....	36
Bayag-kabayo .....	36
Bayag-usá .....	70
Beech .....	110
B'eus .....	23
Biosan .....	52
Birch .....	110
Biuas .....	48
Biuis .....	48
Biús .....	48
Black Walnut .....	110
Bombacaceae .....	22, 25, 34
Brownlowia .....	24, 25, 34
Brownlowia lanceolata .....	22, 34
Bruguiera .....	24, 25, 42, 89
Bruguiera caryophylloides .....	22, 52
Bruguiera conjugata....	16, 23, 42, 45, 46, 48, 52, 64, 84, 87, 106, 108, 110, 111, 113, 114, 115
Bruguiera cylindrica....	16, 22, 42, 46, 48, 50, 51, 64
Bruguiera eriopetala .....	22, 48, 117
Bruguiera gymnorhiza .....	22, 48, 117
Bruguiera parviflora....	13, 16, 22, 23, 42, 46, 48, 52, 53, 55, 84, 87, 88, 106, 108, 110, 113, 114, 117
Bruguiera sexangula....	16, 22, 23, 42, 46, 47, 48, 49, 64, 90, 114, 115
Brugiera sp .....	106, 108, 110, 111
B'rus .....	23
Bubutigan .....	52
Bulali .....	66
Bulokbúlok .....	62
Bulubadiáng .....	56
Buis .....	48
Bunayon .....	40
Buñálon .....	34, 74
Buñálong .....	40
Busáin .....	22, 23, 42, 46, 48, 83, 86, 87, 88, 90, 113, 114
Busai-ing .....	46
Busáing .....	48
Busi-ing .....	46
Buta .....	34
Buta-buta .....	22, 23, 34, 70
Buto-butó .....	70

	Page.		Page.
Caesalpinia crista .....	18	Firewood .....	105
Caesalpinia nuga .....	18, 95	Forest charges .....	126
Camptostemon .....	25, 34	Fuel value of mangrove firewood .....	110
Camptostemon philippinense .....	22, 23, 34, 35	Galura .....	76
Catutan .....	106, 108, 110, 111	Gapas-gápas .....	22, 23, 34
Cerbera .....	24, 26	Glochidion littorale .....	20
Cerbera manghas .....	22, 70, 73	Gregorio .....	76
Cerbera odollam .....	22, 70	Griting .....	23
Ceriops .....	24, 25, 42, 89	Gunhùn .....	66
Ceriops candollearia .....	56	Hanbulali .....	78
Ceriops roxburghiana .....	16, 22, 54, 56, 57, 58, 87, 115	Hangálai .....	52
Ceriops spp. ....	23, 110, 116	Hangarai .....	52
Ceriops tagal .....	16, 22, 54, 106, 108, 113, 114, 115, 116	Hapong .....	23
Chanos chanos .....	104	Heritiera .....	24, 25, 36
Chengam .....	23	Heritiera littoralis .....	16, 22, 23, 36, 37
Coconut .....	119	Hibiscus tiliaceus .....	20
Combretaceae .....	22, 25, 62	Hikau-hikauan .....	38
Compositae .....	22, 26, 78	Hingálai .....	52
Cultivation of nipa .....	124	Hingáli .....	48
Cultivation of Rhizophora .....	94	Hoya .....	18
Cumingia philippinense .....	22	Hulit-tengah .....	23
Cuteh .....	116, 118	Hydnophytum .....	18, 21
Cutting planted Rhizophora .....	98	Ilukabban .....	38, 40
Cymbidium .....	18	Jeruju .....	23
Cyperus malaccensis .....	20	Kachang-kachang .....	23
Dagudri .....	76	Kachúchis .....	76
Dalbergia candenatensis .....	18	Kalabayuan .....	48
Daluári .....	76	Kalapani' .....	22, 62, 74, 78
Dalúru-babáe .....	62	Kalapini mangitit .....	74
Dandulit .....	34	Karifurug .....	62
Dendrobium .....	18	Key to genera of mangrove-swamp plants .....	24
Derris trifoliata .....	18	Kundug-kindúg .....	66
Derris uliginosa .....	18	Kolasiman .....	62
Description of mangrove swamps .....	11, 20	Kúbi .....	70
Descriptions of mangrove-swamp spe- cies .....	26	Kulasi .....	22, 34, 62, 64, 66, 74, 78
Diliuariu .....	22, 23, 76, 95	Kulimbáning .....	30
Dischidia .....	18	Lagásak .....	48
Dischidia saccata .....	18	Lagoilói .....	76
Distribution of species in mangrove swamps .....	16	Lagolo .....	22, 23, 26
Ditá .....	70	Lagúndi'-láte .....	78
Djoeroedjoe .....	23	Lagut-út .....	32
Dulokdúlok .....	62	Lánding .....	78
Duluáriu .....	76	Langarai .....	23, 42, 48, 52, 80, 83, 84, 86, 87, 88, 90, 91, 92, 93, 110, 113, 114
Duluk-dúluk .....	66	Langari .....	48, 52
Dumanai .....	66	Lapole .....	26
Dumon .....	36	Lása .....	26
Dun̄gás .....	70	Lenggadai .....	23
Dun̄gon .....	23, 36	Lenggadi .....	23, 106, 108
Dun̄gon-láte .....	22, 23, 36, 91, 92, 93, 94	Libáto .....	62
Dun̄gon-lalao .....	36	Libáto-puti .....	34
Dungun .....	23	Lingóg .....	74
Drynaria quercifolia .....	18	Lipata .....	34, 70
Economic uses of the nipa palm .....	119	Lipatang-buhay .....	34
Elm .....	110	List of species in mangrove swamps .....	22
Epiphytes in mangrove swamps .....	18	Lubanáyong .....	30
Euphorbiaceae .....	22, 25, 34	Lukabban .....	38, 40
Excoecaria .....	24, 25, 34	Lukabbaán .....	40
Excoecaria agallocha .....	22, 23, 34, 35, 70	Lumnitzera .....	25, 63
Fimbristylis ferruginea .....	20	Lumnitzera litorea .....	16, 22, 23, 62, 64, 65
Finlaysonia obovata .....	18	Lumnitzera racemosa .....	22, 62, 64
		Lumnitzera spp. ....	127
		Magalolo .....	62

	Page.		Page.
Magáyao .....	36	Perapat .....	23
Magtañgúd .....	48	Perepat .....	23
Magtoñgóg .....	48	Piadak .....	32
Magtoñgód .....	54	Piagao .....	23
Malarúñgon .....	36	Piagáu .....	22, 30, 32, 80
Maligáng .....	66	Piai .....	23, 26
Manggating .....	23	Piapi .....	76
Manzanilla .....	78	Piapi .....	74
Maóro .....	62	Piay .....	23
Maple .....	110	Piksík .....	74
Maragomon .....	22, 34	Pilápil .....	66
Marketing of Rhizophora firewood.....	101	Pines .....	110
Matangál .....	56	Pipisíg .....	74
Meliaceae .....	22, 25, 30	Pipisik .....	66, 74
Miápi .....	74	Pirara .....	40
Mindoro mangrove swamps.....	117	Pitutan .....	117
Monotbonot .....	66	Planting of Rhizophora .....	95
Myrmecodia .....	18, 19	Pluchea .....	24, 26, 78
Myrsinaceae .....	22, 25, 66	Pluchea indica .....	22, 78
Myrtaceae .....	22, 66	Polypodiaceae .....	22, 25, 26
Nibong .....	23	Polypodium sinuatum .....	18, 21
Nigi .....	30	Port Banga mangrove swamps .....	80
Nigi'-puti' .....	34	Potótan .....	22, 23, 42, 46, 48, 52, 80, 82, 83, 85, 90, 91, 92, 93, 106, 108, 110, 111, 114, 117
Nilad .....	22, 78	Potótan-babae .....	48
Nílar .....	78	Potótan-lalaki .....	22, 42, 48
Nipa .....	14, 22, 23, 24, 25, 26, 28, 29, 94, 95, 119, 121, 123, 124	Pulit .....	30
Nipa fruticans, <i>see</i> nipa.		Pundúg .....	76
Nipah .....	23	Putut .....	23
Nipa seeds .....	119	Putútan .....	23, 48
Niri .....	23	Puyugau .....	32
Nirih .....	23	Rhizophora .....	24, 42, 54, 56, 60, 95
Njiboeng .....	23	Rhizophora candelaria .....	16, 22, 59, 60, 62, 106, 108, 113, 114, 115
Nyireh .....	23	Rhizophoraceae .....	22, 25, 42, 110, 111, 117
Nyireh batu .....	23	Rhizophora conjugata .....	22, 117
Oaks .....	110	Rhizophora mucronata .....	16, 22, 60, 61, 62, 63, 106, 108, 110, 111, 113, 114, 115, 117
Oncosperma .....	24, 25, 26	Rhizophora spp. ....	23, 84, 87, 88, 90, 94, 95
Oncosperma filamentosa .....	22, 23, 30	Róñgon .....	56
Osbornia .....	24, 25, 66	Rubiaceae .....	22, 26, 78
Osbornia octodonta .....	22, 66, 67	Rúñgon .....	56
Pagatpat .....	13, 15, 22, 23, 38, 40, 66, 80, 82, 83, 84, 86, 87, 88, 90, 91, 92, 93, 94, 96, 106, 108, 110	Sága .....	26
Pakos larat .....	23	Sagasá .....	23, 48, 62, 66, 78
Paku laut .....	23	Sagasak .....	48
Pakupakuan .....	26	Saging-saging .....	22, 23, 66
Palalan .....	40	Sala'sá .....	62
Palapát .....	38	Samar mangrove swamps.....	88
Palata .....	38	Sangkuyong .....	32
Paloñgápoi .....	36	Santing .....	62
Pa'ongapuy .....	36	Santing-santing .....	76
Palmae .....	22, 25, 26	Sapinit .....	95
Palugápig .....	36	Sasá .....	26
Panabulón .....	70	Scyphiphora .....	24, 26, 78
Pandakaki .....	70	Scyphiphora hydrophyllacea .....	22, 23, 78, 81
Panting-panting .....	62	Sibuguey mangrove swamps.....	117
Papásil .....	62	Sonneratia .....	24, 25, 38
Paronapin .....	36	Sonneratia acida .....	22
Paronapoi .....	36	Sonneratia alba .....	22, 23, 38, 39, 42
Patpát .....	40	Sonneratia caseolaris.....	13, 15, 16, 22, 23, 38, 40, 41, 43, 106, 108, 110, 114
Páuid .....	26	Sonneratiaceae .....	22, 25, 38
Paunapin .....	36	Sonneratia pagatpat .....	22, 117, 127
Payar .....	38	Sonneratia spp. ....	96
Pedada .....	22, 23, 38		

	Page.		Page.
Specific gravities of mangrove firewood.....	108	Tiliaceae .....	22, 25, 34
Stands in mangrove swamps.....	80	Timbambákis .....	66
Sterculiaceae .....	22, 25, 36	Tindoi .....	76
Sugar from nipa palm.....	126	Tindók .....	66
Sulási' .....	64	Tindok-tindók .....	66
Sulasig .....	66	Tinduktindukan .....	22, 66, 70, 110
Tabáu .....	22, 23, 62, 64, 66, 78, 90, 91	Tinlui .....	76
Tabigi .....	22, 23, 30, 32, 83, 84, 86, 87, 88, 90, 91, 92, 93, 94	Tiwayos .....	66
Tabigue .....	106, 108, 110, 111, 113	Tongóg .....	56
Taboeta .....	22	Transportation of Rhizophora firewood.....	102
Tagása .....	56	Tristellateia australasie .....	18
Taggai .....	23	Troentoem .....	23
Tambo-tambo .....	30	Tuanio .....	66
Tambu-tambu .....	106, 108, 111	Tuawis .....	66
Tangál .....	22, 23, 54, 56, 80, 82, 83, 84, 86, 87, 88, 89, 90, 91, 92, 106, 107, 108, 110, 113, 114, 117	Tuba from nipa-palm.....	122
Tangalan .....	48	Tugisak .....	78
Tangál-lalaki .....	56	Tumu .....	23
Tagasa .....	48	Tunduk-tundukan .....	66
Tanbarks .....	112	Tungód .....	54
Tanghál .....	54	Tungúd .....	56
Taruntum .....	23	Tungúg .....	56
Táta .....	26	Tungung .....	56
Tawalis .....	22, 66	Uakatan .....	62
Tayokón .....	66	Undergrowth of mangrove swamps .....	18
Tengah .....	23, 117	Value of mangrove swamps .....	20
Tengar .....	23	Verbenaceae .....	22, 26, 74
Terentum .....	23	Vinegar from nipa palm .....	124
Thatching from nipa palm.....	119	Xylocarpus .....	24, 25, 30
Thespesia populnea .....	20	Xylocarpus granatum .....	16, 22, 30, 31, 32, 113, 114, 116
Tibigi .....	32	Xylocarpus moluccensis ....	16, 22, 23, 30, 32, 33, 106, 108, 110, 111, 114, 127
Tigbao .....	22	Xylocarpus obovatus .....	117
Tigbau .....	78	Yacal .....	12
		Yield of mangrove bark.....	115

○

